

Horologiographia.
THE ART OF
DIALLING.

Teaching, an Easie and Perfect
Way to make all Kinds of

DIALS

Upon any plain Place howsoever placed.

With the drawing of the Twelve Signes, and
Howes unequalle in them all.

whereunto is annexed the making and use of other
*Dials and Instruments whereby the hours of the day
and Night is knowne.*

Of speciall use and delight, not onely for Students of the Arts
Mathematicall, but also for divers Artificers, Architects,
Surveyors of Buildings, free Masons and others.

By THOMAS FALE.



LONDON, Printed by FELIX KINGSTONE,
dwelling in Peter-Norris-Row, 1652.



SINGULIS AR-
TIUM MATHEMA-
TICARVM STUDIO SIS IN
CELEBERRIMA CANTABRI-
GIENSI ACADEMIA, THOMAS
FALUS EJUSDEM ALUMNUS,
ET VERE MATHESEOS STU-
DIOSUS, EXIGUUM HOC
GRATIANIMI MONU-
MENTUM DD. ANNO 1593.

Simonis Muri ad Lectorem
Carmen.

bra?

*Scire cupis certa cur machia tangitur um-
Et brevis aethereum linea signat iter?
Hac, licet evolvas, facili præcepta libello
Tradita, sed voto non levior a tuo.*





To the friendly Readers, and namely,
to such as be well-willers to the
Mathematicks.

THe Arts Mathematicall (gentle Reader) in regard of their antiquity and excellency (may be compared with any other of the liberall Sciences whatsoever. For *Seth*, who lived in the first age of the world, is commended of *Iosephus*, and *Abraham* of *Berosus*, to have beene skilfull masters in these misteries. And the very name importeth that in old time these of all other were esteemed worthy to be taught, being called for their excellency *Mathemata*, that is, Sciences meet to be learned. These be *Arithmetike*, *Geometry* and *Astronomy*, from which this Art of Dialling taketh his beginning: a knowledg also ancient and necessary, and therefore practised by Princes and famous men of former Ages. The first Diall that histories remember, is *Lib. 2. chap. 20.* of the Kings in the holy Scripture, where the Lord turned the Sunne back 10. degrees for *Hezekias* sake, whereby it had gone down in the Diall of *Abaz*. This *Abaz* was king of *Ierusalem*, and reigned in the 3200. yeere after the creation of the World, and in the first Olimpiade of the Grecians. Afterward, as *Plinie* writeth, *Anaximenes Milesius* the scholler of *Anaximander*, first found out the reason and proportion of shadowes amongst the Lacedemonians, and there taught the Art of Dialling, who lived 200. yeere after the reigne of *Abaz*, and was a famous Philosopher in *Greece* before *Platons* time, as *Diogenes Laertius* reporteth. But some affirme that it was *Anaximander* himselfe that found out this Art, and set forth the first Mappe of the Earth.

To the Reader.

Lib. 2.

Herodotus saith that the Grecians learned this art, and the division of the day in 12 houres, of the Chaldeans. *Diodorus* writeth that one *Hyperion* first observed the houres. But if wee may beleeve *Macrobius*, it seemeth that this Science came from the Egyptians for they called the Sun *Horus* which by his motion limiteth to each houre his appointed time.

Lib. 9.

Varronius rehearseth sundry inventors of this art of Dialling, as *Berosus* the Caldean, *Aristarchus*, *Samius*, *Endoxus*, *Theodorus* with others who were renowned, and lived many yeeres before the birth of Christ, I need not here remember *Architas Tarentinus*, who by art made a Dove of wood to fly in the ayre: neither *Archimedes*, who defended *Syracusa* against *Marcellus*, and affirmed that if he had a place to stand on, he would move the earth with his engines: both of them no doubt skilfull in this Science.

*Plutarch in
Marcel.*

It was long after the invention that this Art was known in *Rome*: for in the 12. tables was only mentioned the rising and setting of the Sun, and after certain yeeres the mid day was added. Then in the first *Punike war* the *Romans* obtaining victory, there was a Diall brought forth among other spoyles out of *Sicily*. But in processe of time they began to be more common in *Rome*: for 100 yeeres before *Cleopas* time, the parasite in a Comedy, being hungry spake against the multitude of Clocks and Dialls which were then in the City, *Optans ne suis coniugis venter sit horologium.*

Lib. 36. c. 10.

Plinius also telleth of a Diall placed in the field of *Flora* at *Rome*, which by the space of 30 yeeres had not aged with the Sun; & the reason was as he thought, because that either the Sun had taken a new course, or else the earth was slipped from his Centre, wherein at the first it stood, or the stile was put a wry by the shaking of the city. Since which times learning spreading it selfe into divers parts of the world, this Art hath bene amongst the rest in great account.

Concerning the profit of this Art, daily experience teacheth, how needfull it is in a well ordered Common-wealth, seeing nothing can be done in due and convenient season, where this Science is neglected for the division of the day

into

To the Reader.

into certain parts or houres (which this Art teacheth) doth
limite and allot to each action his due time. This Art being
then so ancient, and the use so necessary, I must none will
thinke this labour superfluous, unlesse they be rude without
civility, or such as have alwayes at hand a Diall of natures
framing, of whom this vers seemeth to be made :

Si tunc ad solem statuas no natus blandus

Ore, bene ostendat dominus hora quae est.

Morus.

Many have promised (but none as yet performed) to
write of this Science in our English tongue, which had been
published in other Languages, as *D. Record* long since, *M.*
Digs, *M. Blagrove* with other, who if they would take the
paines, I know could doe it with great commendation

Divers have written hereof in the Latine tongue, as *Mun-*
ster, *Schenerus*, *Orentius*, *Witskendus*, *Clavius* and others :
yet every one differing from other in precept. Some teach
the making of Dialls by the helpe of the Globe, as *Gemma*
Frisius : some by the Astrolabe, as the same *Gemma Frisius*
and *M. Blagr.* which instruments every man have not.
Some use the table of *Sines* and *Arithmetick*, as *Witskendus*,
which way as most plain & easie, is observed in this booke,
though in some kindes for want of triall *Witskendus* deceived
himselfe. *Munster* useth a *Rollifactory* with a circle, which
is unfit for small plats, and faileth in greater, without great
feede. *Schener* wandreth in a wilderesse of lines, that a
man knowes not where to begin, or when to end. *Nlmer*
hath not the Delineation of all kindes.

Othersome observe the rules of Geometrical proportion
which order also we thought to have observed in all kindes, as
we have done in the South & North erect declining, but that
sundry precepts of the same thing would have bred tedious-
nes and trouble to the learner, and the cutting of the Figures
would have bin very chargeable. By meanes whereof we con-
tented our selves with this one way here set downe, not donb-
ting, but that every one with small paines may attaine to the
making of all kindes of Dialls in this booke expressed. As for a
great part of them, every Artificer may easily understand.

To the Reader.

Onely thus much I advertise the unlearned, that they must acquaint themselves with some few Mathematicall principles, as to know what the Elevation of the Pole meaneth, how a squire line is to bee drawn, and such like, which (if they want a teacher) they may sufficiently learn by themselves out of *Records Castle*, his pathway and ground of Artes, published in the English tongue: for these tearmes could not be avoided, neither plainly described without much tediousnesse.

Wee have here added also Examples and Figures to every kinde, that so the precepts might appeare more plaine and easie: so that there is no plain plat or wall, howsoever it standeth, or be placed either Declining, Reclining or Inclining but by the helpe of this booke you may draw a Diall upon it.

If any man complaine of obscurity, hee must know, that *Difficilia qua pulchra*, and yet small paines overcommeth all.

The making of the Horologicall Cyindre, and the Ring with some other instruments, we have presently omitted, partly for their curiosity in cutting and delineation, and partly because (if occasion serve) we will entreat of these kindes of Horologicall instruments by themselves, together with the making of all kindes of plaine Dialls in this booke, prescribed by the way of Geometricall proportion.

In the meane while (gentle Reader) committing
this booke to thy favourable acceptation,
and thy selfe to the protection of
the Almighty, I end.

THOMAS FALKE.

To my loving kinsman *Tho. Osborne.*



His Book, which seven yeere since was in a manner perfected (as you know) doth now upon this occasion presents it selfe to the view of the world: wherein you have taken such pains for the triall of each example, that I think none can finde any great fault; but such as can see farre into other mens faults, & forget their owne. For after we found some precepts in Witelkindus to be false, we were enforced to try and examine with great care each figure and example in the same. And therefore if any receive benefit by this our triall, I would you should have your due praise you deserve. I have altered some few things; & added the making of the South & North Erect declining Dials, by the way of Geometricall proportion: because those kinde be most in use, and I would the learner should have his choise of the easiest way. The graver of the Figures was one M. lod. Hondius who hath shewed himselfe an excellent workeman in the great Globes set forth by M. Mullineux, and the Maps of England for M. Camdens booke: and whether he hath performed like diligence in these I referre it to your selfe to iudge. If any be desirous to have the instrument mentioned in the beginning of this booke, for the tryall of platts, I hope you will helpe them to it: for being of your owne invention, I know none so fit as your selfe to make it: on which instrument also, it were convenient to draw the quadrant Horologicall that so it might serve for divers uses.

I trust you will not be offended, in that I leave under our names this small monument unto the world, as a speaking witnesse of our thankfull hearts to this our Countrey, and a testimony of our affection towards the Arts Mathematicall. Thus beseeching the Lord (who hath endued you with extraordinary knowledge in all Maxuall Sciences) to finish that good worke of his heavenly grace already begun in you, to his glory and your owne comfort I take my leave. Commend me many times to your selfe, and all our good friends. From London, January 3. 1593.

Yours assuredly, *T. F.*

Advertisemens to

the Reader.

NOte alwaies that in every Diall the one end of the Stile must bee placed directly towards the North Pole, and the other end towards the South Pole: for about these two starres the whole heavens are moved, they remaining immoveable. The North Pole is a starre in the North part of the heaven, being raised above the earth or our Horizon 52.4. And this changeth his height, if you goe Northward or Southward one degree in 60. miles: but Eastward or Westward it altereth not. The elevation of the Pole is the height of this Star above the earth.

Observe also, that the Substile is the line or place over which the Stile or Gnomon in your Diall directly hangerh. The space betwene Stile and Substile is the just height thereof.

One line cutteth another squirewise, when they make right and equall angles.

The Contingent or touch line, is that which is drawne by any point of another line or circle, so that it toucheth the same: and this line commonly in all Dialls is drawne squirewise to the substile,

A quadrant is the forth part of circle.

The Meridian and twelve a clock line are all one.

I call these lines parallel, which are every where of like distance one from another: example whereof you may see in the East and West diall, where all the houre lines be parallel.

You may make all kinds of plaine Dialls upon one stone, if you prepare it first to be square like a Dye, and then take off the eight corners, and all the sharpe sides, so shall you have 25. plaine plats besides the base, or soote whereon your Diall must stand

If any be desirous to have this instrument ready made, let him enquire at the Printers, and he shall heare of them.

THE



The making of an Instrument to

find out the situation of any place or

Diall, and to place them al-

ready prepared.

CHAP. I.



Pro much as it is necessary be-
fore you can draw any Diall, to
know how your place is situate
ought afterward to be placed, it
shall be expedient to shew the
making and use of an Instrumēt
whereby you may examine and
try all plaine plats, and place all
dialls being ready made and pre-
pared.

Provide thereof an half circle of Pear-tree, Walnut-
tree, Box, or any other close grained and solid wood being
well seasoned, so that the alteration of the weather at any
time may not make it change from the first proportion ther-
of. Let it be perfectly tryed on both sides of an even thick-
nesse, halfe or three quarters of an inch thick or more if you
will, and six or eight inches broad as you thinke good. The
edge of side A. B. must be very right. Then draw the Line
C. D. three quarters of an inch equally distant from the side
A. B. place one foot of your compasses in the centre E. which
is the midd of the line C. D. and with the other draw halfe a
circle from C. to A. divide it into two equal parts of qua-

The Art of Dialling.

planes and laying your ruler upon the centre E. and upon this Division draw the line E.F. this done, divide each of these quadrants into 90 equal degrees of parts, which you may thus doe: First divide each of them into 3 equal parts and every of these into three other parts, so shall you have 9 divisions in either quadrant. whereof every one shall represent ten degrees. Again, part every one of these into 2 and each of those into five (if you can) and so is each quadrant divided into 90 degrees.

Proposition. It is necessary if your Instrument were large enough, to part each degree into 60 minutes or at the least into 3. whereof each part may containe 10 minutes This done, fasten a thread well waxed, in the centre E. with a plummet of lead on the end, so that it may move at free liberty.

You may also (if you will) upon this Arc of the quadrant between E.D. draw the dial, whose delineation is taught in the 8 Chapter.



The

The Art of Dialling.

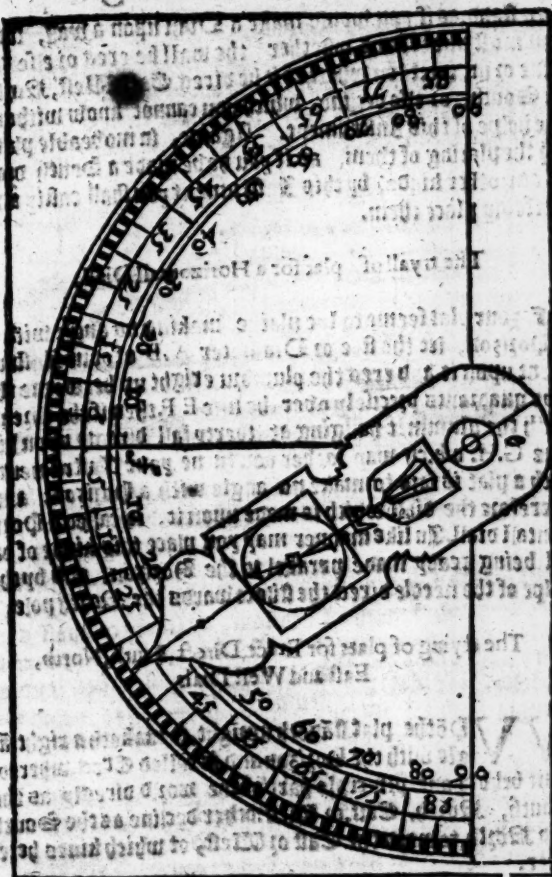
Prepare a piece of very good wood, try it perfect in both sides to an equall thickness. Let it be about half an inch thick, and twice so broad as the space betwene the line C.D. of your instrument and the edge A.B. In the middest thereof draw the right line G.H. and placing one foot of your compasses in the point G. with the other make a halfe circle according to the breadth of the ruler, whereby you may cut the end round, make the other end with a sharpe point right in the end of the line G.H. as you may see in this figure.



Let the distance betwene the point G. and the end H. be so much as is the semidiameter of the quadrant made by G. A hole so great, that a plummet of lead hanging by a thread from the sharpe end, may move therein at liberty: Make also another round or square hole, wherein you may place a needle touched with a Loadstone, as in the compasses of dyall you see. Finally, make a little hole in the point or centre G. and with a broad headed nalle of brasse fasten it upon the centre E. of your instrument, so as it may move and slide which way you will, and then your Instrument is finished.

Note that you may make your Instrument in a forme of a square triangle right angled, as Workmen traceth, cutting a round furrow without the circle and degrees made, for a plummet to hang at liberty in: so shall you neede but one line of your instrument to use with a compass or needle to direct you in the construction. But the forme of the other, whole making you have taught, seemeth more convenient, to hold the figure.

The



Chapter 2.
The use of this instrument is to determine the placing
 the plat of diall. In immediate plate, to know how
 they

The Art of Dialling.

they stand, as if you would make a Dial upon a wall, first you must understand whether the wall be erect or else recline or incline, whether it be direct East, West, North or South, or else decline, which you cannot know without the helpe of this Instrument. Again, in moveable places for the placing of them, as if you have made a South diall of any other kinde, by this Instrument you shall easily and perfectly place them.

The tryall of a plat for a Horizontall Diall.

If your plat seeme to lye plaine, making no angle with the Horizon, let the line of Diameter A.B. of your Instrument, be set upon it, and erect the plumbline right up betwene the two quadrants precisely over the line E.F. then if the thread with the plummet hanging at liberty fall directly upon his line G.H. which way soever you turne your Instrument, such a plat is said to make no angle with a Horizon, and therefore the diall which is made upon it, is called a Horizontall diall. In like manner may you place this kinde of diall being ready made parallel to the Horizon, and by the helpe of the needle direct the stile towards the North pole,

The trying of plats for Erect, Direct, South, North, East and West Dials.

VVhen the plat standeth upright, it maketh a right angle with the Horizon and is called Erect, whereof some beholds one principle part of the world directly as the South, North, East, or West, other decline as the South and North, toward the East or West, of which kinds hereafter.

To examine an Erect plat, apply the line of diameter A.B. of your Instrument unto it, the thread with the plummet on the fore side hanging at liberty, till the thread fall upon the line E.C.E.D. the plat is Erect.

The Art of Dialling. 4

This done, apply the said line of diameter A.B. to the plat your Instrument being placed equally distant to the Zenith, and the plumbline upon the line E.H. when it is in a right stand directly over his character: the end touched with the Loadstone being next to the plat, that year is called a South Erect Direct.

In the north all the foresaid things are to be considered except only that the end of the needle touches with the loadstone is farthest from the plat.

These things knowne, you may easily find out the East and West Erect Direct; if either you have a line of gnomon square to the character of the needle, or else if you place the plumbline over the line E.C. or B.D. and the needle be

And here note, that the East and West are not said to decline, because the declination is accounted from the south and North to the direct East and West points.

The examining of plats for Declining

All such plats as be not some principall part of the Horizon directly, are called Declining. The quantity of their declination is found out thus.

Apply the diameter A.B. of your Instrument to the plat remembering to hold it out equally distant from the Zenith. Then move the plumbline until the needle standeth right over the character, and the point of the ruler which toucheth the degrees in the limb. Shall shew how many degrees and minutes it doth decline: either toward the east if the plumbline lie in the quadrant C.E.F. or toward the west, if in the quadrant D.E.F.

The trying of such Plats as decline.

If the plat standeth not upright, but maketh an obtuse angle with the Horizon, it is said to recline. The degrees

The Art of Dialectics

The degrees of the Declination are found out thus.

Apply the Diameter A.B. of your instrument of the plate the one end placed upon the other diameter of the circle the diameter of the board with a plummet hanging free will ensuit the thread hang precisely over the line G.H. then the point of the ruler shall shew the degrees of Retraction.

How inclining plans are tried

But if the angle which the plate makes with the horizon be acute or sharp then it doth incline. The quantity of inclination is thus known.

Apply the Diameter A.B. of your instrument to the part, the thickness of the planer of the former for hanging at liberty, and make what degree and minute the thread shall cut for so much is the inclination.

The manner of trying those plates which recline and decline, or incline and decline.

If youe plot that both rectine and Decline of sideline and
Longitude of it Clocke out the declination as hath beene spec-
ed, and then the declination is in **Every Drawing.**

6. The making of a hole in the top of the pipe.

For first being prepared inward and outward upon these lines, both the square following the last A. B. C. D. E. F. G. H. I. K. L. M. N. O. P. Q. R. S. T. U. V. W. X. Y. Z. making themselves squirewise, that is making right angles in the point E. upon which make the quadrant of any circle from the line E. C. to the line E. A. or E. B. and write at C. the 32nd at D. the South at A. the East at B. the West at C. and so forth. And so shall you have the quadrant being divided into 32 parts.

tion of the Pole shall be accounted in it, which in our example is 52. from C. to A. and at the end of this number draw a line from the centre E. which shall be E.F. representing the stile and Axis of the world. Then draw another line K.L. by C. or by some other point of the line C.D. square-wise, so long as you can, which shall be called the touch line, or line of Contingence. When measuring with your Compasses the least distance of the point O. and the line E.F. for 5 stile. the one foot places in O. which is the point of intersection, and the other extended towards E. where it then chance to divide or be placed in the line E.F. Marke that point of centre with the letter G. and draw with your Compasses a halfe circle upon this centre for the Equinoctial circle, from H. by C. to I. whose Diameter must be equall distant to the line L. K. then divide this half circle into 12 equal parts, thus done, lay a Ruler upon the centre G. and figure every marke of division made in the half equall, and where the Ruler shall cross the line of Contingence, there make markes of pycks, by which pycks draw lines from E. for the houres E. C. is the 12 houre E. B. the 6 in the morning E. A. the 6 at evening, the rest you may see in the Figure

And whereas in Summer the 4 and 5 in the morning, and also the 7 and 8 at evening, shall be necessary in this kinde of Diall, prolong or draw the lines of 4 and 5 at evening, beyond the centre E. which shall shew the houres of 4 and 5 in the morning. And likewise the 7 and 8 in the morning, for the 7 and 8 at evening.

You may observe an other both in these and still other erect direct Dialls, by drawing the one halfe of the Equator drawing house lines for the forenoone, and extending the same distance from the Meridian line, on the other side for the afternoon, for the line of the 12 houre in the forenoone, is of like distance from the Meridian, that the 1 is in the afternoon, and the 10 and 11 of the rest.

When you would draw or make the half houres, you must divide every part of the Equator into 2 equal parts, using the Ruler and the line of Contingence as you finde it.

The Art of Dialling.

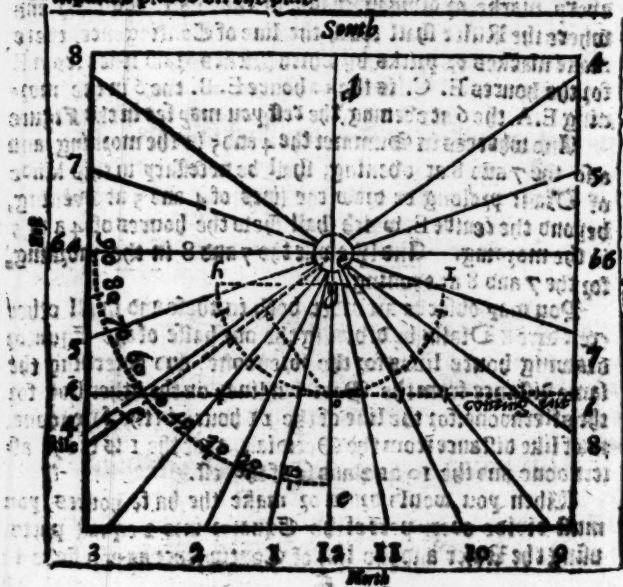
the drawing of the houre-lines.

And this remember for the drawing of the halle houre lines, not onely in this kinde, but also in all other kindes of dialls which afterward shall follow.

The stile must be fixed in the centre E. hanging perpendiculer to the Meridian line E.C. with so great an angle, as the lines C.E.F. make, declining from that on neither sides.

The equinoctial circle, the Quadrant, the line of the stile and of Contingence must be lightly draught, because they ought to be put out againe, in that they serve to no use but for drawing of the Diall. And this likewise remember in all other kindes of Dialls, that the preparative or prickted lines must after the making of the Diall be dimitted and extinguished as altogether unprofitable.

This and all other kindes of Dialls may most fitly be done upon a cleane paper, and then with the helpe of your compasses placed on the plat.



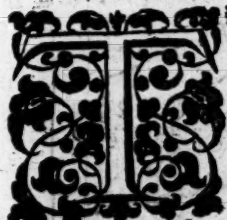
The

The Art of Dialling.

6

The making of a south erect, direct Diall.

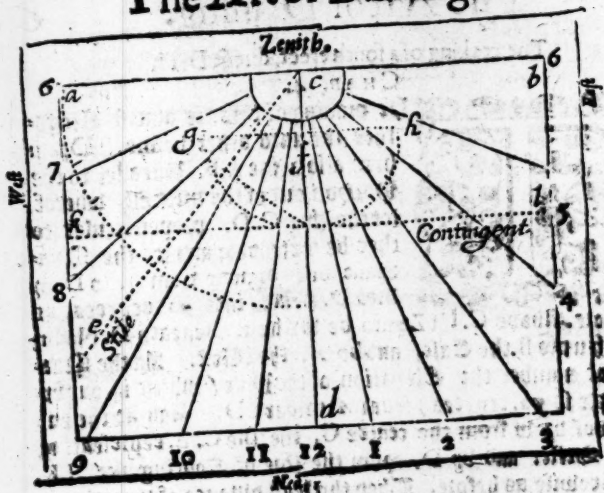
CHAP. 4.



The making of this, is almost altogether like unto other before. Draw here also a line A.B. Parallel to the Horizon, out of the middlest whereof, let the line C.D. perpendicular to that be extended; and let the Quadrant bee drawne from A. to D. or B. to D. parted into 90 degrees, as before. Above C. let Zenith be written, beneath D. Nadir; nigh unto B. the East, and by A. the West. In the Quadrant number the Elevation of the Pole (which in our example is 55. degrees) from A. toward D. And at the end hereof draw from the centre C. the line C. E. representing the Style; and by D. draw the line of Contingence, I.K. squarewise, as before. When the least distance of the point of intersection D. and the Style being taken with your Compasses extend them in the line D.C. the one foot placed in D. let the other in F. toward C. and draw by F. the Diameter of the halfe circle of the Equator equal distant to the line K.L. which must be made upon the centre F. from G. by D. to H. and divide it 1. to 12. equal parts. upon every one of which and the centre F. the ruler being placed, wheresoever it shall happen to touch the line of contingence, there make marks. Then from the centre C. by these marks the houre-line must be drawne. The line C.A. shall shew the 6. houre in the morning, C.G. the 6. at evening, C.D. the 12. etc. The Style must be placed or fixed in the centre C. hanging precisely over the line of the 12. houre, with so great a distance as the angle D.C.B. is. This kinde of Diall both receiveth and sheweth 12. houre at the most.

The

The Art of Dialling.



The Making of a North Erect direct Dial.



CHAP. 5.
 Ere as in the South make a line
 Parallel to the Horizon. A. B.
 put it square with the Per-
 pendicular C. D. let C. be the
 centre. At C. write Zenith, at D.
 Nodis &c. From C. draw the
 Diameter of a circle to D. & B.
 divide this into 90 Degrees
 according to the Elevation of the
 Pole (which in our example is 52. d.) from A. towards C.
 Draw at the end of this number the line E. F. for the Style.
 Afterward draw the line Contingent by G. square with
 and take the shortest distance with your Compasses between
 the point C. and the Style, placing the one foot in the point
 C.

The Art of Dialling. 3

C. extend the other toward E. in the line C. D.: making $\frac{1}{2}$ Point or yick G.: whereupon (as a centre) the same wizeth Beffe of the compalles remaining, bescribe the half Equator by C. ended with the Diameter. H. I. equidistant to the line of Contingence. When you have divided this halfe circle of the Equator into twelue equall parts, lay the ruler upon the centre G. and upon each diuision of the Equator; and where it shall touch the Contingence, thus make marke. This done draw the lines for the houres, by those marke. from the centre E. but those very few, that is, two nigh unto A. and two by B. but prolong and extend the same beyond the centre B. so that their contraries may be made. for in this kinde of Dials there be but onely tenne houres profitable, that is, 4, 5, 6, 7, 8, before noone, and 4, 5, 6, 7, 8, afternoone; which few but onely in the summer, from the entering of the Sunne into γ until such time it entrench Δ .

The *Stile* must be fixed in the centre B. placed upward, directly over the line E.C. with so great an angle as I.E. C. is. Let the line C.D. be placed upward perpendicularly, but so, that it may not be almost scarce, as afterward serving to no use, because it is only a line preparative.

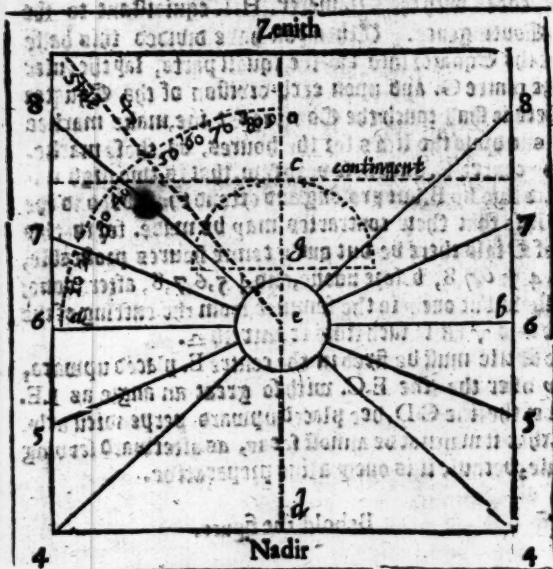
Behold the figure.

63

A North

The Art of Dialling.

A North Dial erect direct.



The making of the East and West Erect Dials.

CHAP. 16.



If you know the making of one of these, you may easily make them both, for they be very like, differing onely in the naming of the houres. For the one containeth houres for the forenoone, and the other for the afternoone.

You must therefore on your plat make the Diameter of a circle A.B.C. which may afterwards be easily put out, as all

all the other lines must bee, except the houre lines: let the A. B. be Perpendicular, B. C. Parallel to the Horizon and let the arke behold the South, which being divided into 90. degrees, number therein the elevation of the pole downward from A. toward C. by the end of this number, and by the centre B, draw a line so long as your plat will give you leave, whose South end shall behold precisely the Equinoctial circle. At which end draw a circle, whose Diameter shall be almost the third part of the line. Then draw another, Diameter, of line in the Centre, equidistant to the other, which shall shew the axis of the world, and be the line for the 6. houre. Afterward draw the outward sides of the circle draw two contingent lines, one beneath the other above, so that they may be Parallel to the middle line. Divide each quarter of the circle into six equal parts. Then place the ruler upon the centre, and each of those marked parts, and where it toucheth the line of contingence, there make marks in them. Afterward draw a line by those two marks which be next to the 6. houre, in the lines of contingence, which may be equally distant from the line of the 6. houre.

In like manner doe with the rest, so that you may have in the East Dial two above the 6. houre, the 4. and the 5. in the morning, and under it 7, 8, 9, 10, 11. In the West Dial likewise 7. and 8. in the evening about the 6. houre, and under it 6, 5, 4, 3, 2, 1. Neither of them doe shew the 12. houre, because at that time the Sunne beames be parallel to the plat.

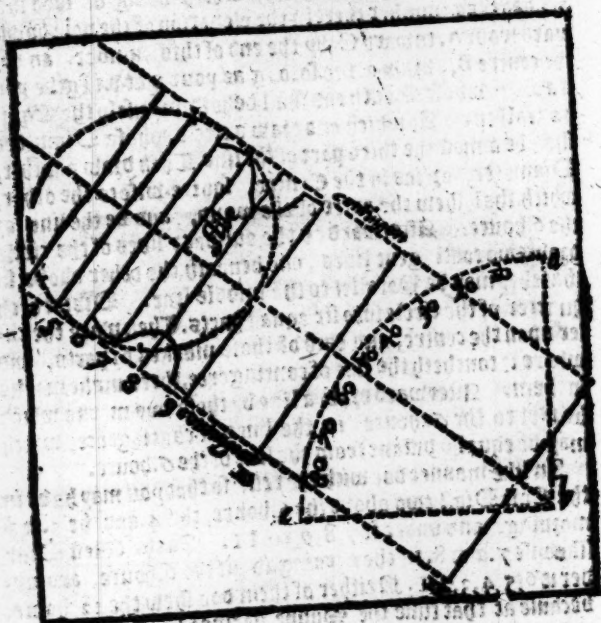
Fix the Style in the centre of the circle right up from the Plat, so long as the Semidiameter of the circle is onely shewing the houre with the very top or end thereof. Yet it shew in one convenient to have it placed along over the line of the 6. houre, being a plate of yron or some other metall, being so broad as the Semidiameter of the circle is.

Behold the figures following.

The

The Art of Dialling.

An Easy Diall Brō.

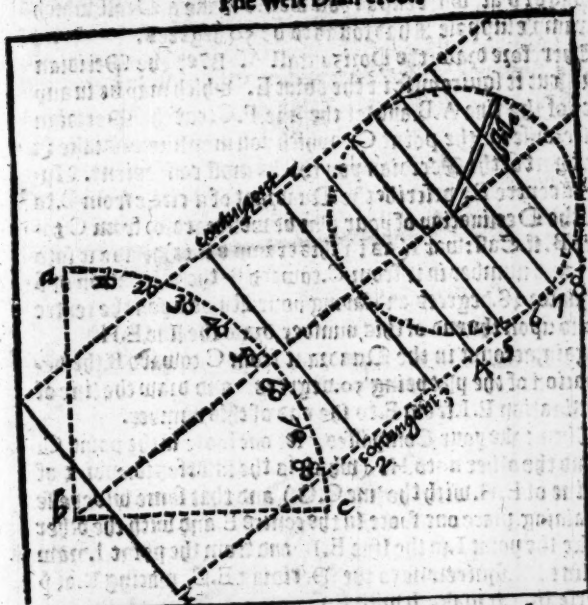


The first thing to be done is to draw a line representing the meridian of the place, and then to draw a line perpendicular to it, representing the equinoctial. The intersection of these two lines will be the center of the dial. From this center, draw a circle of any radius, and then draw a line from the center to the circumference, representing the hour line. The angle between the meridian and the hour line will be the hour angle, and the distance from the center to the circumference will be the hour distance. The hour distance is the same for all hours, and the hour angle is the same for all days of the year.

The second thing to be done is to draw a line representing the equinoctial, and then to draw a line perpendicular to it, representing the meridian. The intersection of these two lines will be the center of the dial. From this center, draw a circle of any radius, and then draw a line from the center to the circumference, representing the hour line. The angle between the meridian and the hour line will be the hour angle, and the distance from the center to the circumference will be the hour distance. The hour distance is the same for all hours, and the hour angle is the same for all days of the year.

The Art of Dialling: T 9

The west Dial erect.



Note that these five kinds of Dial's before taught may be made upon a stone cut square in the forme of a dial. The making of a South Erect declining Dial, which may be placed on any upright wall whatsoever.

CHAP. 7.

In all Declining Dials because the stile doth not hang directly over the Perpetian line, therefore you must first finde out and place the Substile (which is the line over which the stile directly hangs) and likewise the line of the stile which may be both easily and speedily performed in this manner. First by your Instrument seek out the Declination of the

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the

The Art of Dialling T

the wall or plat, whereupon you would make a Diall, which
for example I suppose I had found to be 50 degrees.

Therefore draw the Horizontall A. B. let the Peridian
C. D. cut it squarewise in the point E. which may be in any
place of the line A. B. and let the line F. C. cut the Peridian
squarewise in the point C. which you may likewise take in
what part of the Peridian you thinke most convenient. Up-
on the centre E. describe the Quadrant of a circle from C. to
A. if the Declination of your place be westward, or from C. to-
ward B. if Eastward: as in this example it is divide it into
90. and number in it from C. toward B. the Elevation of the
Equator 38. degrees and laying your Ruler upon the centre
E. and upon the end of this number, draw the line E. H.

Again, account in the Quadrant from C. toward B. the de-
clination of the place being 50. degrees. and draw the line of
Declination E. I. from E. to the end of this number.

Then take your Compasses, for one foot in the point C.
extend the other unto H. (which is the intersection point of
the line of E. H. with the line C. G.) and that same width
remaining, place one foot in the centre E. and with the other
marke the point I. in the line E. I. and from the point I. draw
the line I. K. squarewise to the Peridian E. C. placing K. at the
intersection: it make h with E. C.

Before we take with your Compasses the full length of
the line I. K. and placing one foot in E. turne the other toward
F. and make the point L. in the line C. F. draw the Substile
from E. by L. Let the line of Contingence be drawn square-
wise to the Substile in the point L.

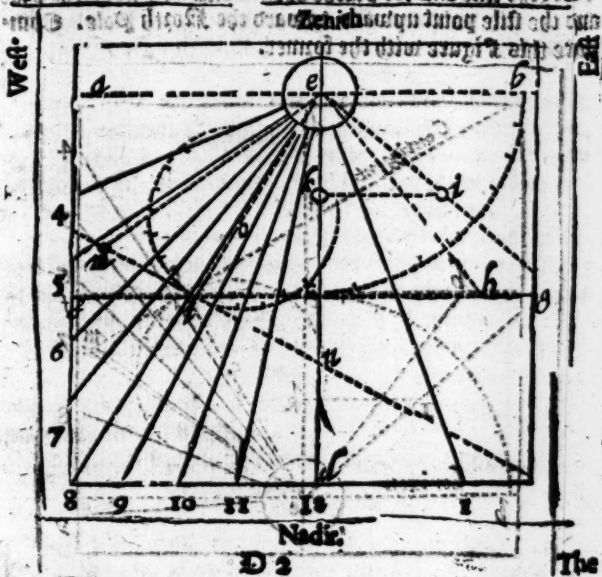
This done, take the distance between the centre E. and
the point K. and place it in the line of Contingence from the
point E. unto M. and make the point M. that the line E. M.
may be made from E. unto M. for the Style.

Measure with your Compasses the least distance between
the point L. and the Style and with the same width, one
foot remaining in L. turne the other toward B. and make
the centre O. in the Substile upon which describe the Equi-
nodial

nodall circle. Then placing your Ruler upon O, being the centre of the equinoctial circle, and N; (which is the point of the intersection of the Peridian & Contingent) marking where it cutteth the circumference thereof, you must begin to divide it into 24 equal parts, notwithstanding those 12 are onely in use which are next the Contingent.

Finally, place your ruler upon the centre O, and upon the severall division points of the Equator, and where it toucheth the line of Contingence, make marks, by which from the centre E draw the hour lines.

Place the Peridian perpendiculary upon the wall, the centre E upward, the stile pointing downward. Let the stile hanging directly over the Substile making an angle equal to E.M.L.



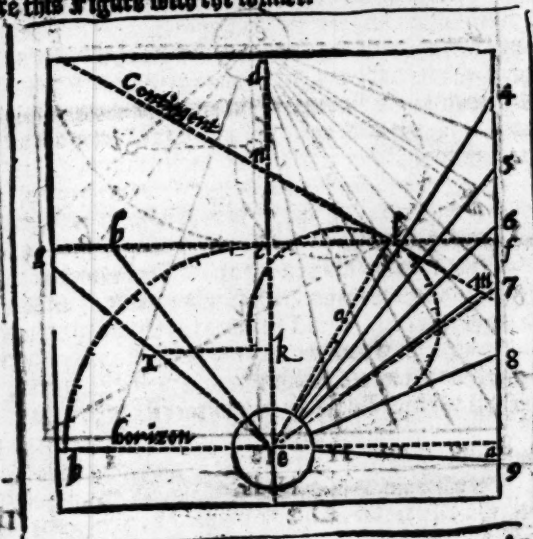
The Art of Dialling.

The making of a North Rect Declining Diall. CHAP. 8.

In the North Rect declining Diall differeth from the South one herein, that the centre is to be placed downwards, the stile pointing upward to the North Pole, and that the Peridian representeth the 12 houre at midnight and at noone. Therefore if the declination be toward the East, you must abate the houre lines from that which is as it were the Peridian to the East, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12.

But if it decline toward the West, number them backward, 11, 10, 9, 8, 7, 6, 5, 4, 3, 2, 1, 12, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, as omitting the 12, which are before Noone rising and after Noone setting in our Elevation.

Let the line E.D. be placed very perpendicularly toward the stile and the stile point upward toward the North Pole. Compare this Figure with the former.



Another

The Art of Dialling.

11

Another way to make a South Erect
Declining Dial.

CHAP. 9.



Albeit we have plainly and perfectly
shewed the making of the South and
North Erect Declining Dials in the
two former Chapters, yet to satisfie
them that desire in variety, there is
a so declared another way, whereby you
may make them namely by the helpe of
Arithmetick, and the Table of Signes which is placed in
the end of this booke for this intent.

Therefore the Elevation of the Pole being knowne, and
the Declination of your plat, by your Instrument found
out;

Multiply the Signe of the Complement of the Elevatio
by the Signe of the Complement of the Declination, divide
the product by the whole Signe (which is a 100000) and you
shall have a quotient Signe, whose Arke is the distance of
the stile from the Substile, which distance keepe.

Then take the Complement of this distance, and the E
levation of the Pole, and multiply the Signe of the lesser by
the whole Signe, parting the product by the Signe of the
greater, the quotient Signe, which shall come off this divi
sion, shall give you an Arke, whose Complement is the di
stance of the line of the Substile from the Peridian; which
distance you shall likewise keepe. For better instruction here
in consider the Example.

Example of a South Diall Declining 45.^d Elevation
of the Pole 52.^d.

First Enter the Table of Signes, for the Signe of the
Complement of the Elevation which is 38.^d and I find

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it

The Art of Dialling.

it to be 61366. Then I looke for the Signe of the Complement of the Declination, which is 45.^d. & I find that to be 70710. This done, I multiply the one by the other and the product is 4353331360. which I divide by the whole Sine being 100000. whereof cometh a quotient 43533. With this quotient Sine I enter the Table, and because I finde not the just number, I take that which is next of her greater or lesse unto it: (which you must alwayes remember to doe) for so small a difference maketh no alteration, & therefore I take in stead hereof 43523. whole Arke is 25.^d. 48.^m. which is the distance of the stile from the Substile.

Then I take the Complement of this distance, which is 64.^d. 12.^m. whole Sine is 90031. and the Elevation of the Pole 52.^d. whole Sine is 78801. & multiplying the Sine of the lesser, (which is the Elevation of the Pole) by the whole, 100000. the product is 7880100000. which I divide by the Sine of the greater, to wit. the Sine of the Complement of the distance of the stile from the Substile, whole Sine is 90031, whereof cometh this Quotient 87526 whole Arke is 61.^d. 5.^m. The Complement of which Arke is 28.^d. 55.^m. being the distance of the Substile from the Meridian. These distances being thus found out, the dialling of the Diall followeth.

First, draw a line Parallel to the Horizon A. B. out of whose middle point C. draw the Meridian line North-west C. D. upon the centre C. make the Quadrant of a circle between A & D. Here understand that generally to all kindes of Declining Dialls, if the declination be towards the East, you must draw the Quadrant towards the west, (except in a South reclining declining, and the North inclining declining where the Contrary is prescribed.) But if the declination be Westward the Quadrant be drawn Eastward: Verily you shall easily know on which side you ought alwayes to draw the Quadrant, and which way the figures following doe decline. Your Quadrant being made, divide it into 90. degrees, and number therein from D.

the distance of the Substile from the Meridian, which is 25.^d. 55.^m. Draw at the end of this number the line C.E. for the Substile. Then from E. towards A. account the distance of the stile from the Substile, which is 25.^d. 48.^m. and at the end hereof, draw the line C.F. for the stile. Afterward by the point E. or in any place of the Substile draw the Contingent G.H. so long as you can squire: wile to the Substile. Then take with your Compasses the least distance betweene E. and the stile the one foot remaining in E. and then the extended in the Substile toward C. place at the pike there made with the Compasses. I upon which pike as a centre, the same wideness of your Compasses remaining, draw a circle by E. which shall represent the Equinoctial or Equator. Then lay the Ruler upon the point I. and the intersection (whose marke is K.) of the line of Contingence, and the line C.D. (which is alwayes drawne so that it may cut the other) and where the Ruler so placed shall touch the circle, there make a marke, and there begin to divide it into 24. equal parts: notwithstanding those 12 onely are to be used, which doe behold the Contingent line. Then lay the ruler upon the centre I. and the Contingent line by every division of the Equator, and where it shall touch the line of Contingence, there make markes, by the which from the centre C. draw lines for the houres, so many as shall be necessary.

The line C.D. shall alwayes shew the 12. houre, which must hang perpendicularly. Number the rest of the lines in their place as they follow in order.

The line A.B. in such as do decline is unprofitable, excepte in so chance that some houre line falleth in it.

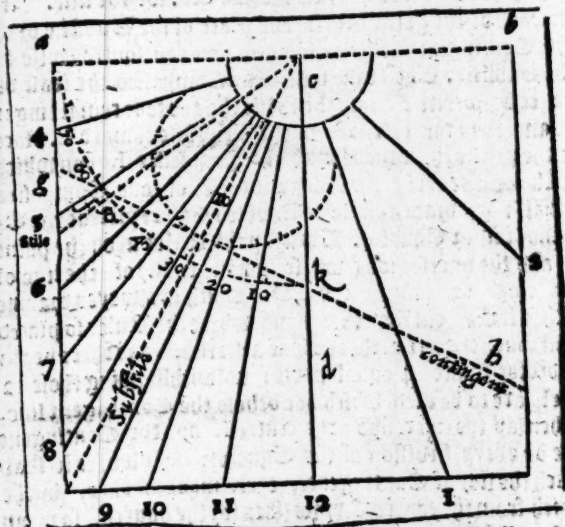
Let the line be fixed in C. hanging directly over the Substile, with so great an angle, as E.C.F. is, declining on neither side.

Note diligently the making of this declining Diall, because in those which follow, we meane not to repeat those things which have here been taught. And this one kinde well

The Art of Dialling.

well knowne all the other will seeme most easie. For better understanding hereof, behold the Figure.

A South Erect declining Diall.



The making of a north Erect declining Diall another way

CHAP. 10.



The distance of the Style from the Substyle, and of the Substyle from the Peridian, is found out altogether like to the South Erect declining. Therefore you may resort thither for the working hereof. I will onely draw the Figure.

Let

Let the line A. B. being parallel to the Horizon, cut C. D. squarewise placing E. at the intersection. Draw the quadrant from C. to B. divide it into 90. ^{d.} accounting therein from C. toward B. the distance of the Substile from the line, which is (as it were) the Peridian, which distance is 28. ^{d.} 55. ^{m.} At the end of this number draw the line E. F. for the Substile. Then number from that line the distance of the Substile and the Style, which is 25. ^{d.} 48. ^{m.} toward B. Draw likewise at the end of this number the line for the Style E. G. This done let the line of Contingence be drawn squarewise by the point F. and then taking the least distance between the point F. and the Style, extend the compasses in the line F. E. the one foot being placed in F. where the other shall hit the line, place the letter H. With the same wideness of the compasses draw upon the centre H. the Contingent, and where the ruler shall touch the same being laid upon the centre H. and the intersection of the Contingent line, and that which is (as it were) the Peridian, begin to divide it into 24. equal parts. Finish all things remaining, as in the Surveyer's declining, only this excepted, the Style being fixed in the centre E. must be placed upward, beholding the Substile with so great a distance or angle, as the letters F. E. G. doe shew. The line C. D. being applied to the plate perpendicularly, sheweth as it were the 12 houre at midnigh: therefore account from that the houre lines, as they follow in order, 1, 2, 3. which houre have no use in this kinde of Diall, for our Elevation, but from

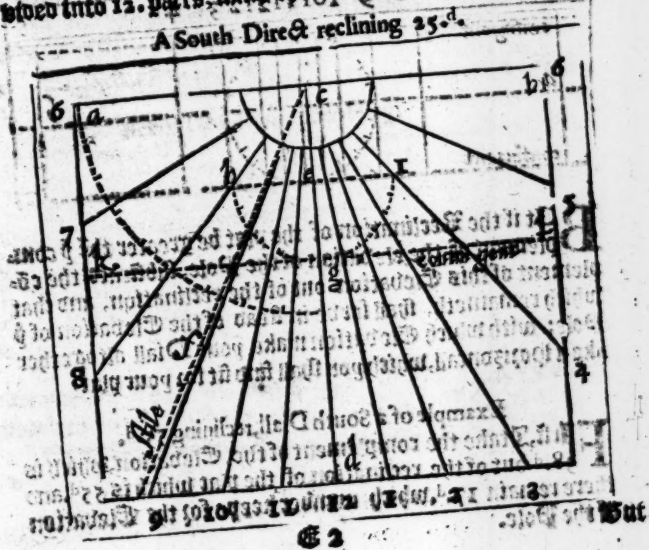
4. Let the line A. B. being parallel to the Horizon, being likewise squarewise, as the other preparative lines be, being applied to the plate, divide it into 90. ^{d.} accounting therein from C. toward B. the distance of the Substile from the line, which is (as it were) the Peridian, which distance is 28. ^{d.} 55. ^{m.} At the end of this number draw the line E. F. for the Substile. Then number from that line the distance of the Substile and the Style, which is 25. ^{d.} 48. ^{m.} toward B. Draw likewise at the end of this number the line for the Style E. G. This done let the line of Contingence be drawn squarewise by the point F. and then taking the least distance between the point F. and the Style, extend the compasses in the line F. E. the one foot being placed in F. where the other shall hit the line, place the letter H. With the same wideness of the compasses draw upon the centre H. the Contingent, and where the ruler shall touch the same being laid upon the centre H. and the intersection of the Contingent line, and that which is (as it were) the Peridian, begin to divide it into 24. equal parts. Finish all things remaining, as in the Surveyer's declining, only this excepted, the Style being fixed in the centre E. must be placed upward, beholding the Substile with so great a distance or angle, as the letters F. E. G. doe shew. The line C. D. being applied to the plate perpendicularly, sheweth as it were the 12 houre at midnigh: therefore account from that the houre lines, as they follow in order, 1, 2, 3. which houre have no use in this kinde of Diall, for our Elevation, but from

The Art of Dialling

14

Example and delineation of a South Dial,
reclining 25.^d.

Example 2. *reclining 25.^d.*
Make the first line A. B. draw also another C. D. cutting the other with right angles. Then add the Complement of the elevation of the Pole (which is 25.^d. to the reclination of the plate (which is 38.^d. and the total summe shall be 63.^d. which number being in place of the Elevation of the Pole, account it in the Quadrant from A towards D. and at the end thereof, draw the line F. for the Style. Then make the line of Contingence K. L. squarewise to the line C. D. Afterward take the least distance with your compasses betwene the point G. and the Style with the widened the one foot extended toward C. make a point of prick E. by which point draw the line H. I. perpendicular from A. B. or K. L. upon E. make a half circle frō H by G. to I. which being divided into 12. parts, finish the rest as the fourth erect direct.

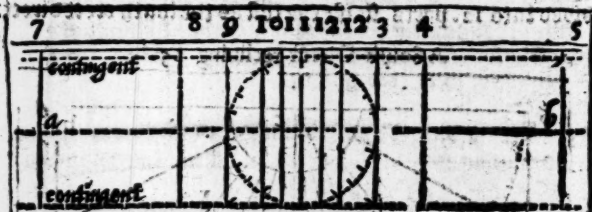


The Art of Dialling.

But if the Rectination be equal to the complement of the Pole, make your Dial on this manner, like to the East and West.

Draw a line Parallel to the Horizon A.B. so long as the plat will give you leave, divide it into 7. equal parts, and with the same widenesse of the compasses in the midst of β line make a circle representing the Equator. Then draw two lines of Contingence by the circumference of the circle equidistant from the first A.B. Divide the Equator into 24 equal parts. Finally the rest like the East or West dial except in naming the houres, for that which is in them the 6. houre line, is here the 12. &c.

A South Direct reclining 38° .



But if the Rectination of the plat be greater the complement of the elevation of the Pole, subtract the complement of this Elevation out of the rectination, and that which remaineth, shall serve in stead of the Elevation of β Pole: with which Elevation make your Dial altogether like a Horizontall, which you shall find fit for your plat.

Example of a South Dial, reclining 55° .

First Take the complement of the Elevation, which is 38° , out of the rectination of the plat which is 55° , and there remain 17° , which number keepe for the Elevation of the Pole.

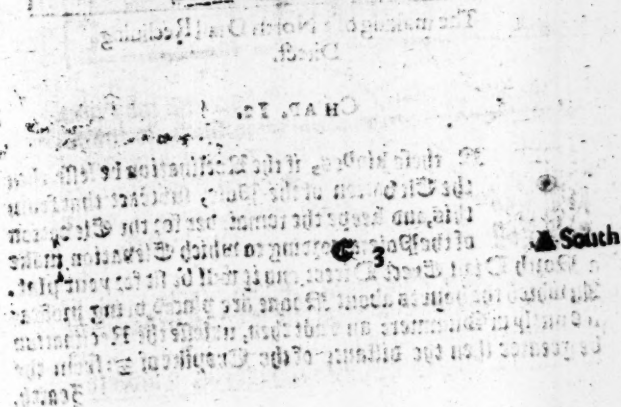
The Art of Dialling!

15

In Detachment of this Dial, draw a line Parallel to the Horizon A.B. draw another C.D. making right angles with the line A.B. Then make the quadrant from A. to D. which being divided into 90. degrees, number in it, that which is, as it were the Elevation of the Pole, namely 17. degrees from D. towards A. Then draw the line of Contingence K.L. in any point of the line C.D. squarewise. Take with your compasses the least distance of the point G. and of the Sella: extend them both in the line C.D. I mean, from G. toward C. make there a point marked with E. upon which point of centre with the same wideness of the compasses draw the Equator from H. by G. to I. divide it into 12. equal parts, &c.

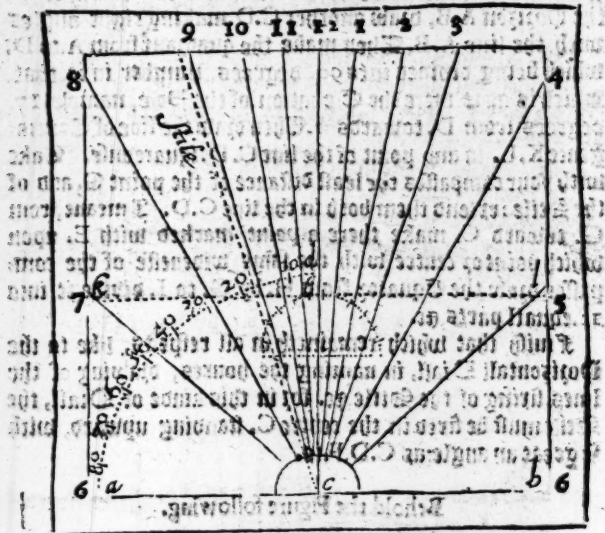
Finish that which remaineth in all respects, like to the Horizontal Dial, in naming the houres, drawing of the lines spring of the Sella, &c. for in this kinde of Diall, the Sella must be fixed in the centre C. standing upward, with so great an angle, as C.D.F. is.

Behold the Figure following.



The Art of Dialling.

A South Rectling Erect.



The making of a North Dial Rectling Direct.

CHAP. I2.

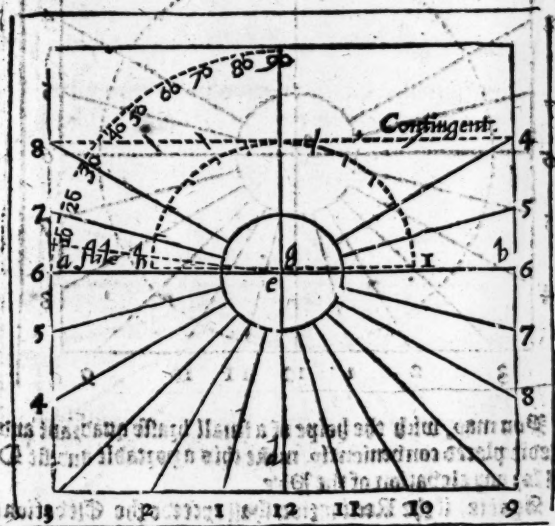
In these kindes, if the Reclination be lesse then the Eleuation of the Pole, subtract that from this, and keepe the remainder for the Eleuation of the Pole: according to which Eleuation make a North Dial Erect Direct and it will be fit for your plat. In which the houres about Noone are placed, being profitable onely in Summer: an o not then, unless the Reclination be greater then the distance of the Tropike of \varnothing : from the Zenith,

Zenith. And the more your Diall reclineth, the longer time it will shew in Summer.

Example of a North Diall reclining 45. degrees

First, I take the Elevation of the Pole (which we account 52.^d.) out of the Reclination of the plate, which is 45.^d. and there remaineth 7.^d. which shall bee in place of the Elevation of the Pole.

Then for the drawing of it, resort to the North Erect Diall, because their Declination is like. Remembering allways to call that which remaineth, the Elevation of the Pole: which in this example is but 7.^d. In the figure following you see, that most part of the houre lines be drawn opposite from the Contingent, beyond the centre E. as you must doe in any of this kinde, if you will have the houres about noone.



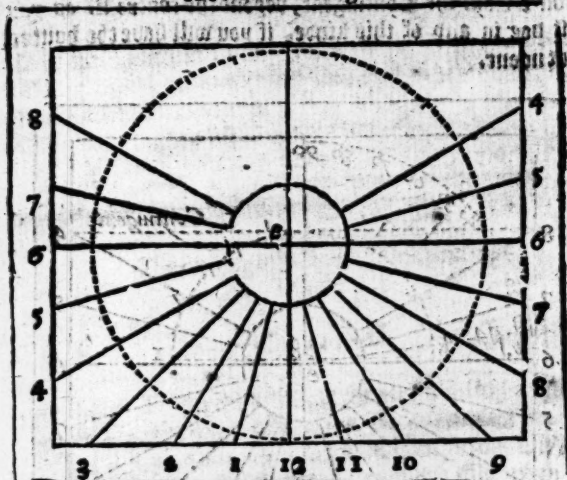
Example

The Art of Dialling.

Example of a North Dial Reclining 52. degrees.

But if the reclination be equall with the Elevation of the Pole: then describe a circle upon the centre E. & divide it into 24. equal parts, beginning the division at the 12. houre. Draw by those points, lines for the houres from the centre E. so many as shall be necessary: drawing the Style (being some small tape) in the centre E. right up. This kind of Dial serveth only when the Latitude is in the North figures which be V. 8. 11. 12. 13. 14.

A North reclining Direct.



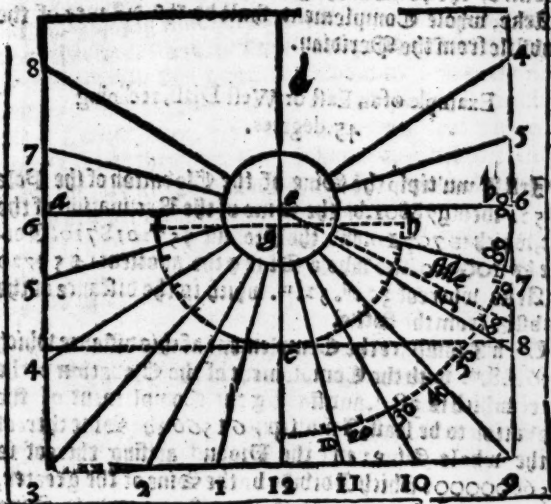
You may, with the helpe of a small brass quadrant and a needle placed conveniently, make this a portable and fit Dial for any elevation of the Pole.

Again, if the Reclination shall exceed the Elevation of the

the Pole: adde the complement of the reclination to the Elevation, and with that number, as if it were the Elevation of the Pole, make your Diall altogether (like a Horizontall, and it shall be fit for your plat. In which notwithstanding in winter, very few houses have, and those about noone: and yet not these, unless the reclination shall be greater, than the highest bending of the Tropike γ from the Zenith.

Example of a North Diall reclining 10.
First, adde the complement of the reclination of the plat which is 10, to the Elevation of the Pole 52. And with the totall number 62, as if it were the Elevation of the Pole, make a Horizontall Diall, as is before Chap. 3. It mayes remember to adde the two numbers together, The Elevation of the Pole.

A North declining diall.



The

The Art of Dialling.

The making of an East and West
Dial reclining.

CHAP. 13.



First, multiply the Sine of the elevation of the Pole, by the Sine of the Reclination of the plat, and divide the product by the whole Sine: whereof shall come a quotient, whose arke is the distance of the stile from the Substile.

Compare the Complement of this distance with the Complement of the Elevation of the Pole, and which you shall find less, multiply the Sine thereof by the whole Sine, parting the product by the Sine of the greater. The quotient shall give an Arke, whose Complement shall be the distance of the Substile from the Meridian.

Example of an East or West Dial, reclining
45. degrees.

First I multiply the Sine of the Elevation of the Pole 52.⁴. being 7801. by the Sine of the Reclination of the plat, which is 70710. and the Product 5571018710. I divide by 100000. the whole Sine & the quotient is 55720 the Arke whereof 32.⁴. 52.^m. which is the distance of the Substile from the stile.

Then I compare the Complement of this distance which is 56.⁴. 8.^m. with the Complement of the Elevation of the Pole, which is 38.⁴. and finding the Complement of the Elevation to be less, I multiply 67566 the Sine thereof by the whole Sine: and the Product arising thereof is 6156600000 which I divide by the Sine of the greater, which is the Complement of the distance, whose Sine is

The Art of Dialling.

18

is 83033. And the Quotient 74141. yeeldeth an ark 47.^d 51.^m. whose Complement is 42.^d 9.^m. which is the distance of the Substile from the Peridian.

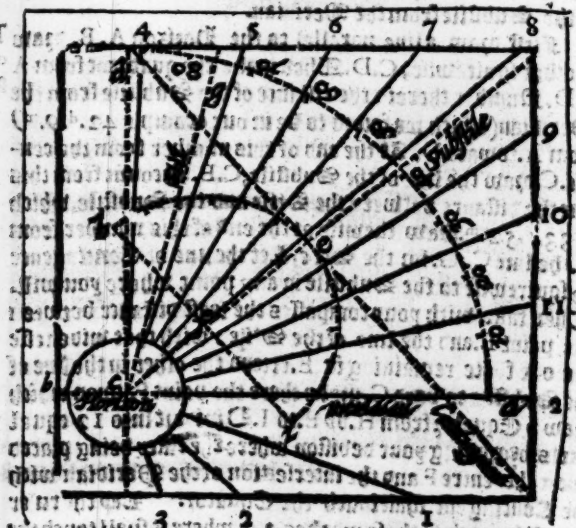
First draw a line parallel to the Horizon A. B. draw another squirewise, C. D. Then make the quadrant from A to D. Number therein the distance of the Substile from the Peridian (which we found to be in our example 42.^d 9.^m) from A. toward D. At the end of this number from the centre C. draw the line of the Substile, C. E. Account from this line the distance between the stile and the Substile, which is 33.^d 52.^m. draw likewise at the end of this number from C. the line C. G. for the stile. Let the line of Contingence be squirewise to the Substile in any point where you will. Then take with your compasses the least distance between the point E. and the line of the stile, with that indigence the one foote remaining in E. extend the other in the line of the Substile toward C. make there the point F. upon which draw the Equator from H. by E. 40 I. Divide it into 12 equal parts beginning your division where the ruler being placed upon the centre F. and the intersection of the Peridian with the Contingence shall touch the Equator. Lay the ruler from F. by each of those markes, and where it shall touch the line of Contingence, there make markes by which from the centre C. draw the houre lines so many as shall be necessary. The line A. B. is the Peridian, and betwixt the 12 houre. Finish al other things as in the rest before you were taught.

Note that if it be an East dial, you must make the quadrant from A. to D. If a West, from B. to D. Finish the rest as before.

The delineat.
on of the Fi-
gure.

An

An East or West reclining.



The making of a South reclining declining Dial.

CHAP. 14



First, in this kind, as in other which follow, you must find out and place the Meridian, the Substile, and the stile, which being done, that which remaineth is finished as in those before.

Wherefore the Declination and the Reclination of the plat being known by your Instrument, multiply the Sine of the declination by the Sine of the

the complement of the Declination, adding the product by the whole Sine. The quotient Sine shall yield an Arke, whose complement shall be named the Complement to be repeated.

Afterward augment the Sine of the Complement of the Declination, by the whole Sine, divide the product by the Sine of the complement to be repeated: whereof shall come a sign, whose Arke shall be the distance of the Part from the Horizon.

Again, multiply the Sine of this distance, by the Sine of the Complement of the Declination, part the Product by the whole Sine, the Arke of whose quotient shall be called the Elevation of the Meridian.

Then compare this Elevation of the Meridian, with the Elevation of the Pole, and which you shall find least, subtract that from the greater, and that which remaineth keep, (for it shall be called the difference kept) being mindful which of them was the greater.

This done multiply the Sine of the Complement to be repeated, by the Sine of the difference kept: dividing the Product by the whole Sine, whereof shall come a Sine, whose arke shall be the distance of the stile from the sub stile.

To conclude, compare the Complement of this distance with the complement of the difference kept: and which you shall find least, multiply the Sine thereof by the whole Sine, part the Product by the Sine of the greater, and thereof shall come a Sine, the Complement of whose Arke shall be the distance of the Sub stile from the Meridian.

Example of a South Dial

Declining 18.^o.

Reclining 25.^o.

First looke out in the Table the Sine of the Declination which is 30901. Then the Complement of the Declination being 65.^o, the Sine hereof is 90630. Afterward multiply 90630. by 30901. and the product 28005 57630

3

divide

The Art of Dialling.

divide the whole Sine, which is 100000. the quotient shall be 28005. whose arke is $16^{\circ} 16'$. The Complement whereof being $73^{\circ} 44'$. is the Complement to be repeated.

This done, multiply 95105. the Sine of the Complement of the Declination 72° . by the whole Sine 100000. the product shall be 951050000. which being divided by 95996. the Sine of the complement to be repeated, the quotient shall be 99071. whose arke is $82^{\circ} 11'$. which is the distance of the Meridian from the Horizon.

Afterward augment the Sine of this distance 99071. by the Sine of the complement of the Declination, which is 90630 and the Product 8978804730. part by the whole Sine and the quotient 89788. shall yeeld an arke $63^{\circ} 53'$ which is the Elevation of the Meridian.

Then compare the Elevation of the Meridian with the Elevation of the Pole, which in this example is 52° . and finding the Elevation of the Pole to be least, subtract this (namely 52°) from $63^{\circ} 53'$. the Elevation of the Meridian, & there remaineth $11^{\circ} 53'$. which is difference kept.

Now multiply 95996 being the Sine of the Complement to be repeated, which is 20591. the Product is 1976653636. which divided by the whole Sine, the quotient shall be 19766. whose arke $11^{\circ} 24'$. is the distance of the Style from the Substile.

Then to conclude, the Complement of this distance, which is $78^{\circ} 36'$. being compared with the Complement of the difference kept, which is $78^{\circ} 7'$. you shall find the Complement of this difference kept to be least, wherefore multiply 97856. the Sine thereof, by the whole Sine and the product 9785900000. part by the Sine of the greater to wit, of the complement of the distance of the Style from the Substile, which is 98027. the quotient shall be 99825 whose arke is $86^{\circ} 37'$. The complement whereof is $3^{\circ} 23'$. which is the distance of the Substile from the Meridian.

There

The Art of Dialling. 20

There be three sundry kinds of these Dials, the one differing from the other.

The first kind.

Marke therefore if the Elevation of the Meridian be greater then the Elevation of the Pole, draw a line parallel to the Horizon A.B. out of the middest whereof extend another C.D. squarewise to the line A.B. make the quadrant from A. to D. number therein from A. towards D. the distance of the Meridian from the Horizon, which is $82^{\circ} 11^m$. at the end hereof at the centre C. draw the line C.E. for the Meridian.

From which account backward towards A. the distance of the Substile from the Meridian, which is $3^{\circ} 23^m$, draw at the end of this number the line C. F. for the Substile.

Then from the Substile toward A. number the distance of the Substile from the stile 11 Degrees, 24. minutes, and at the end thereof extend the line C. G. which shall represent the stile. This done in the line of the Substile in the point F. (which you may take where you will in the Substile) draw the line of Contingence squarewise to the Substile. Then take the least distance of the point F. from the stile.

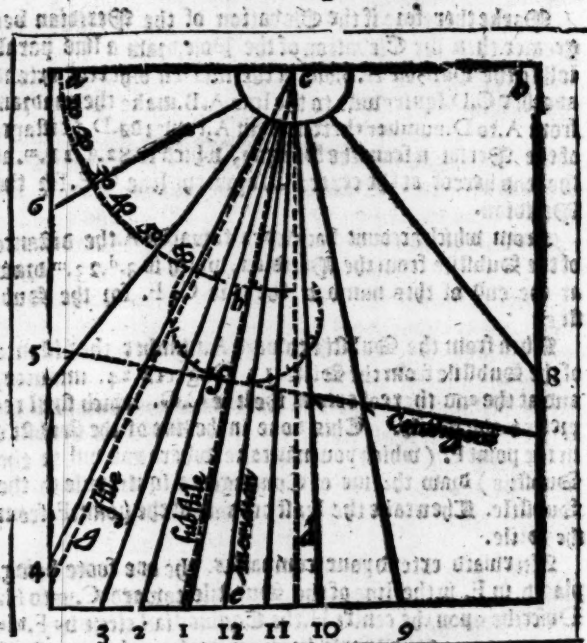
Afterward extend your compasses, the one foote being placed in F. in the line of the Substile toward C. unto H. Describe upon the centre H. the Equinoctial Circle by F. divide it into 24. equal parts beginning where the ruler shall touch the Equator, being placed upon the centre H. and upon every marke of the Equator, and where the ruler shall touch the line of Contingence, there make markes, by which from the centre C. draw the houre lines so many as shall be necessary, C.E. alwayes shewing the 12 houre. Let the stile hang directly over the Substile with so great an angle as F. C. G. is: lying in the centre C. pointing downe.

The Art of Dialling.

downward to the Pole Antarctick.

Place the line A. B. parallel to the Horizon, having at-
tention, as other preparative lines, no use.

A South declining reclining.



The second Table.

But if the Elevation of the Pole, and the Elevation of
the Meridian be found equal, the making of your Diall
differeth from the former yet the finding out of the Meridian
and the Substile. ec. is wrought as in the other before,
whether

whither you may referre. It shall be sufficient here to shew
an example of this kinde.

Example of a South Diall whole
 Declination is 33° ^d
 Reclination is $33^{\circ}4'30''$ ^m
 Elevation of the Pole is $51^{\circ}4'2''$ ^m

First I multiply 52991 the Sine of the declination, by
 83388 the Sine of the Complement of the Reclination,
 and the product 4481813508 arising thereof, I divide by
 the whole Sine: the quotient Sine 44188 yeeldeth an arke
 $26^{\circ}4'14''$ ^m whose complement being $63^{\circ}46''$ ^m is the com-
 plement to be repeated.

Then I increase the Sine of the Complement of the de-
 clination, which is 84804 by the whole Sine, and the pro-
 duct is 8480400000 : which I part by 89700 being the
 Sine of the Complement to be repeated. The arke of whose
 quotient Sine 94541 being $70^{\circ}4'59''$ ^m, is the distance of
 the Meridian from the Horizon.

This done I multiply this Sine 94541 by the Sine of
 the complement of the reclination, which is 83388 , and the
 product arising hereof, being 7883584908 , I divide by the
 whole Sine: quotient thereof is 78835 whose arke $51^{\circ}4'2''$ ^m
 is the Elevation of the Meridian, which I compare
 with the Elevation of the Pole, and finding them equal, I
 end my worke here. For this shall be sufficient in this kinde
 of Diall, as you may more plainly perceive by the deline-
 ation of the Figure.

Wherefore if the Elevation of the Pole, and of the Me-
 ridian be found equal, (as in this example it is) make a line
 parallel to the Horizon A. B. Draw another C. D. making
 right angles with the line A. B. Draw the quadrant from
 A. to D. number therein the distance of the Meridian from
 the Horizon from A. toward D. which is $70^{\circ}4'59''$ ^m. being
 here in place of the Substile. Then draw the line of Con-
 tingence (quite wile to the Meridian C. E. (which is also the
 Substile)

The Art of Dialling.

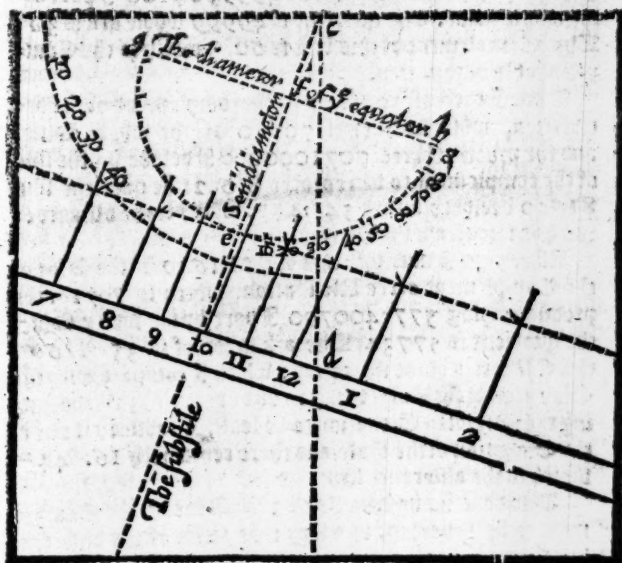
Substile C. E. in any point thereof, as before: Place one foot of your Compasses in the intersection E, then let the other foot in the Meridian O Substile, being of any wideness make there the point O centre F upon which centre draw the half Equator from G by E to H, Divide the one halfe thereof from E. towards H. the declination of the plat 32.4 place the ruler upon the centre F. and the end of this number, and where it shall touch the Contingent line, there make a marke, by this marke, you must draw a line squrewise to the Contingent line which shall be for the 12 hours. And where the ruler shall touch the Equator, there begin to divide it into 12 equal parts, by which lay the ruler from the centre F. making in the line of Contingence markes for the other houre lines, all which shall cut the Contingent line squrewise. Note sometime in dividing of the Equator, the two parts at both ends next to the Semidiameter G H shall both of them make but one whole part, unless you will make a whole circle for the Equator and divide it into 24 parts.

Let the Stile be a small wyer standing right up in the point E. being so long as the Semidiameter of the Equator. It may be also a plate of iron or brasse fastened in the Substile so broad as the Semidiameter is, as in the East and West erect Dialls, &c. Let the line A. B. be parallel to the Horizon. Finish all other things as before.

The Art of Dialling.

22

A South reclining declining.



The third kinde.

If the Elevation of the Meridian be lesse than the Elevation of the Pole, the making of this Diall is unlike to both the other mentione dbefore, yet the finding out of the distance wth the Stile from the Substile, is done like to the first kinde, as by the example following may appeare.

Example of a South Diall { Declining 45.^d.
Reclining 45.^d.
Elevation of the Pole 52.^d.

First, I multiply the Sine of the declination, being 7070

2

by

The Art of Dialling

by the Sine of the Complement of the declination which is likewise 70710, and the product 4999904 100 I part by the whole Sine. The quotient is 49999 whose ark is 30^{d} . The Complement of this Ark is 60^{d} , which is the Complement to be repeated.

Then I increase the Sine of the complement of the declination, which is likewise 70710, by the whole Sine, and the product thereof 7071000000 I divide by the Sine of the complement to be repeated 86602: the quotient Sine 81649 becometh an ark $54^{\text{d}}.44^{\text{m}}$, which is the distance of the Perfolian from the Horizon.

Afterward I multiply this Sine 81649, by the Sine of the Complement of the Declination, which is 70710, the product arising 5773400790 I part by the whole Sine, the quotient is 57734. The ark whereof is $35^{\text{d}}.16^{\text{m}}$, the Elevation of the Perfolian: which I compare with the Elevation of the Pole (being in our example) 52^{d} , and finding the Perfolian Elevation to be least, I subtract it out of the Elevation of the Pole, and there remaineth $16^{\text{d}}.44^{\text{m}}$, which is the difference kept.

This done, I augment 86602 the Sine of the Complement to be repeated, by 28791 the Sine of the difference kept, and the product 2493358182 coming hereof, I divide by the whole Sine, the quotient Sine 24933 becometh an arke $14^{\text{d}}.26^{\text{m}}$, the distance of the Style from the Substile.

Now comparing the Complement of this distance being $75^{\text{d}}.34^{\text{m}}$, with the Complement of the difference kept, which is $73^{\text{d}}.16^{\text{m}}$, and seeing the Complement of the difference kept to be least, I multiply 95765 the Sine thereof, by the whole Sine, and the product 9576500000 I divide by 96843, the Sine of the complement of the distance, and 98886 shall be the quotient thereof, whose ark is $81^{\text{d}}.27^{\text{m}}$. The Complement of this ark is $8^{\text{d}}.33^{\text{m}}$, which is the distance of the Substile from the Perfolian.

In the declination of this Dial, you first as before a line

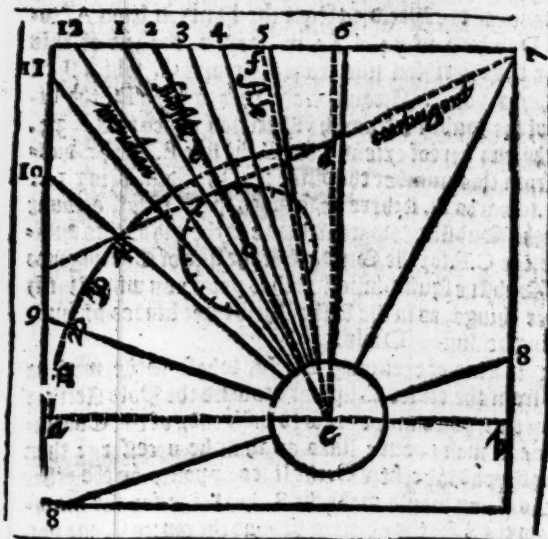
If re Parallel to the Horizon A.B. extend another C.D. making right angles with the line A. B. Draw the Quadrant from A. to D. divide it into 90 degrees. In what account the distance of the Meridian from the Horizon from A. towards D. which is 54. ^d. 44. m. draw a. the end of this number the Meridian line from the centre C. which shall shew the 12. houre. Account from this toward D. the distance of the Substile from the Meridian, which is 8. ^d. 33. m. at the end hereof extend from C. the line E. for the Substile. From this number the distance of the Style being 14. ^d. 26. m. towards E. if there be so much space, if not, account it from the Substile toward A. make at the end of this number the line C.F. for the Style. Let the line of Contingence cut the Substile square-wise, in what point you will. Finish all other things, as in the first of these three kindes of fourth reclining declining Diials.

In this kind of reclining Diials, whose Style must be placed from the centre C. upward toward the Pole Arctike: if at any time you cannot draw to both ends of the Contingent line so many yourde lines as shall be necessary: then prolong beyond the centre C. the lines opposite on the other side. As if you would make the 8. houre line for the morning, draw the 8. for the evening beyond the centre C. and you shall have your desire.

Note that moreover, in this kind contrary to the other before, if the plot decline toward the West, (as in this example it doth) When draw the quadrant toward the West, &c. But if the Declination be towards the East, make the quadrant toward the East.

The Art of Dialling.

A South reclining declining.



The making of a North reclining declining Dial.

CHAP. 15.

The first kind.

In this kind, as in the South before: first, multiply the Sine of the declination, by the Sine of the Complement of the reclination: parting the product by the whole Sine. The Quotient Sine the eof shall bee an Ark, whose Complement shall be called the Complement repeated.

Then,

Then increase in the Sine of the complement of the Declination by the whole Sine, divide the product by the Sine of the Complement repeated: the quotient Sine thereof will give an Arke, which shall be the distance of the Meridian from the Horizon.

The same quotient Sine multiply by the Sine of the Complement of the reclination: and the number arising part by the whole Sine the Arke of this quotient is the Elevation of the Meridian.

Now add the Elevation of the Pole to the Elevation of the Meridian and the totall number of Arke hereof, we will call the compounded Arke. And if the compounded Ark be lesse then 90 degrees: then multiply the Sine thereof, by the Sine of ϕ Complement repeated, dividing the product by the whole Sine: and hereof shall arise a quotient Sine, whose arke shall be ϕ distance of the stile from the Substile.

Now compare the Complement of this distance, with the Complement of the compounded Arke: and increase the Sine of the lesse by the whole Sine, part the Product by the Sine of the greater: and thereof shall come a Sine, the Complement of whose Ark shall be the distance of the Substile from the Meridian.

But mark here the Diversity which doth arise by reason of the compounded Ark: for hereby you shall have three sundry wayes, both in finding out the distances between the Meridian and the Horizon, the stile and Substile. &c. And likewise in the Declination of the figure. Whereof ariseth three sundry kinds of Dials: the first of them being already taught.

The second kind.

If the compounded Arke be full 90 degrees: then the distance of the stile from the Substile shall be the Complement repeated: and the distance of the Substile from the Meridian shall be also 90 degrees.

Note

The Art of Dialling.

Note that in the working hereof, there is no difference from the first kind. For here, as in the other before, you shall first find out the complement repeated: then the distance of the Meridian from the Horizon: Afterward the Elevation of the Meridian, which being added to the Elevation of the Pole, if the totall number be just 90. you shall not need to proceed forward, for this (as before I made mention) shall be the distance of the Meridian from the Substile.

In this kind you shall have no intersection of the Meridian and the Contingent line: therefore you shall begin the division of the Equator at the line of the Substile, which shall be w the 6. houre, either in the morning or evening according as the plat doth decline.

The third kind.

But if the compounded Ark be greater than 90. degrees subtract it from 180. and that which remaineth shall be called the difference kept. Then multiply the Sine of the complement repeated, by the Sine of the difference kept dividing the Product by the whole Sine, hereof shall come a Sine, whose Arke shall be the distance of the Ark from the Substile.

Then compare the Complement of this distance with the Complement of the difference kept, increasing the Sine of the lesser by the whole Sine, and parting the product by the Sine of the greater: whereof shall come a Sine, the complement of whose arke, being taken from 180. degrees the remainder shall shew how much the line of the Substile must be distant (upward by the Horizon) from the Meridian. For the better understanding of these three kinds, marke these three examples following, with the delineation of their figures.

Example

Example of a North Dial } Declination is 45° .
 whole } Reclination 45° .
 } Elevation of the Pole, 52° .

First, I worke this altogether like to the South rectifying 43° Declining 45° until I have found out the Equation of the Peridian.

Then I note the Elevation of the Peridian which is 55° . And the Elevation of the Pole 52° . the total number is $87^{\circ} 16''$ which is the compounded arke: and being less than 90° . I proceed with this arke 87° .

Now therefore I multiply the Sine of this compounded arke, which is 99884 . by the Sine of the complement to the perpendicular being 86501 and I obtaine 8650154168 I part by the whole Sine. The quotient thereof is 86501 which arke $59^{\circ} 54''$. is the distance betweene the Sine and the Substile.

Then I compare $30^{\circ} 46''$. being the Complement of this distance with the Complement of the compounded arke which is $2^{\circ} 44''$. and finding this least, I increase 4768 the Sine thereof, by the whole Sine, dividing the product which is 476890000 . by 50151 the Sine of the greater: the quotient Sine yeeldeth an arke $5^{\circ} 27''$. the Complement hereof $84^{\circ} 33''$. is the distance of the Substile from the Peridian.

In the drawing of this Diall, first as before, make a line parallel to the Horizon A.B. Then extend the line C.D. cutting the other square-wise. Mark the intersection or centre with B. draw thereupon a circle A.B.C.D. whose two quadrants at the least, toward A. (if the plat decline Westward, or else toward B. if it decline Eastward) being divided into 90° . each of them, number therein from H. towards D. the distance of the Peridian from the Horizon which is $54^{\circ} 44''$. and at the end hereof from the centre B. draw the line F. for the Peridian, or 12 houre. Account

to

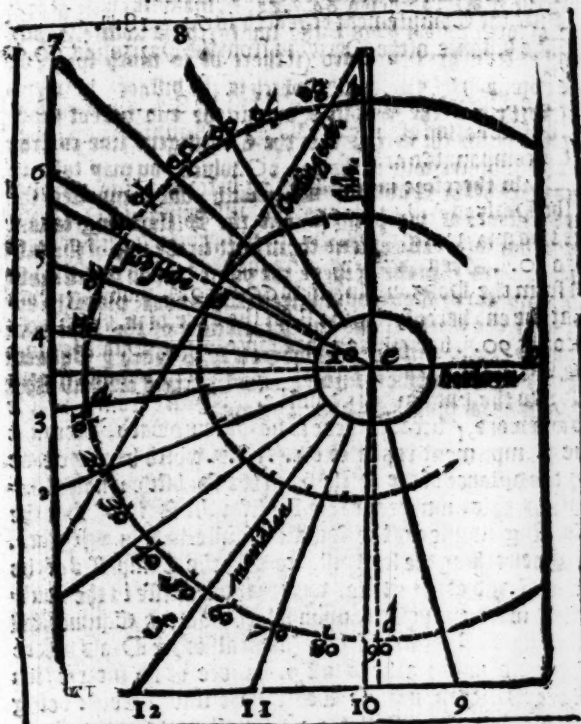
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The Art of Dialling.

from this upward toward C. the distance of the Substile from the Meridian being $84^{\circ} 53'$. make likewise at the end of this number from E the line to the Substile. Against number from hence upward (if there be so much space, or else downward) $59^{\circ} 54'$. which is the distance between the stile and the Substile, and at the end hereof draw the line H. for the stile. Let the Contingent line cut the Substile square-wise in the point G. which you may take in any place of the Substile. Then with your compasses the least distance of this point G. and the stile being taken, with that measure extend them forth in the line of the Substile toward E. making there the point I. upon which is in the Equator of Equinoctial circle. This done place the ruler upon the centre I. and the intersection of the Meridian and the contingent line, and where it shall touch the Equator there begin to divide it into 24. equal parts. Finish all other things, as in those which went before.

A Note

A North reclining declining.



The second kind of North Dial, reclining 45. degrees 14. minutes, declining 38 degrees.

IT shall not be necessary to shew an example of this second kind, because the Complement repeated, the distance of the Peridian from the Substyle, and between the

The Art of Dialling.

the Style and Substile, &c. is found out altogether like to the other before, and that which followeth. Wherefore it sufficeth to set down the number of the distances.

First, the Complement repeated is $64^{\circ} 18^m$.

The distance of the Meridian from the Horizon is $60^{\circ} 59^m$.

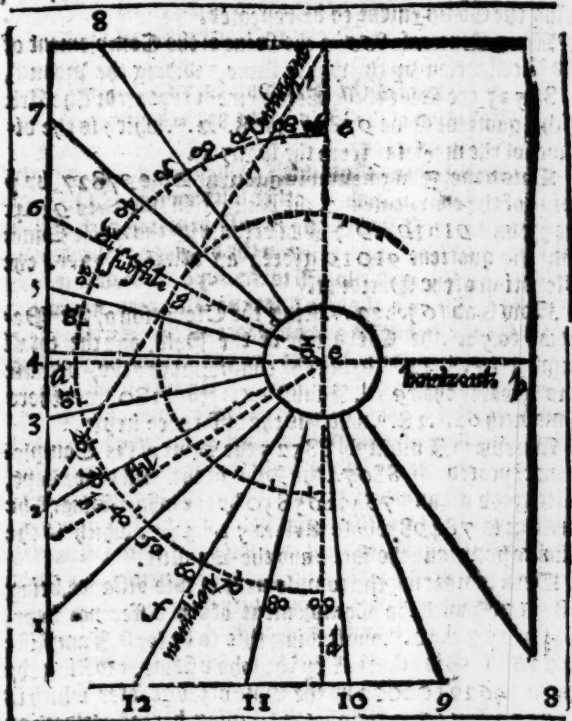
The Elevation of the Meridian is 38° , which I add to the Elevation of the Pole being 22° , and the totall 60° is the compounded arke.

Dial therefore in this kind as before, a line parallel to the Horizon A.B. make another squicewise, C.D. Draw the two quadrants from C. by A. to D. obtaining each of them into 90° . When number herein the distance of the Meridian from the Horizon, which is $60^{\circ} 59^m$, starting from B. at the end hereof, the line E. for the Meridian. From this account 90° , being here the distance of the Substile from the Meridian, and the distance at the end of this number from E. draw the line F. for the Substile. Again from this line downward, (because there is no line upward,) account the Complement repeated $64^{\circ} 18^m$, which here we take for the distance of the Style from the Substile: make likewise by this number the line H. for the Style. Let the Contingent line on the Substile square-wise in any place.

Then taking the least distance with the Compasses of the point G. and of the Style, with that distance in the Substile, make the point I. upon which draw the Equinoctial circle by G. And because here (as in all other Dials where the compounded arke is less 90°) there is no intersection of the Meridian, and the Contingent line thereof: being the division of the Equator 24 equal parts at the Substile, which in this kind shall show the sixth hour, either in the evening or morning, according to the declination of the place. Place the ruler upon the centre I. and so many of these parts as you can, making marks in the line of Contingence as before, upon the hour lines by them, &c. finish the rest as in the other.

A North

A North declining reclinings



Example of the third kinde } Reclining, 21.^d. 30.^m.
of North Diall before }
mentioned. } Declining. 30.^d.

Here first, as before I multiply the Sign of the Declination being 50000,93041 which is the Sign of the complement

The Art of Dialling.

complement of the reclination and $\frac{1}{2}$ product 4652070000
I part by the whole Sine; the quotient 46520 peeldeth an
arke $27^{\circ}.43^{\prime}$. The complement whereof is $62^{\circ}.17^{\prime}$.
being the Complement to be repeated.

Then I increase 8662 the Sine of the Complement of
the Declination by the whole Sine, dividing the product,
by 88525 the Sine of the Complement repeated: The Ark
of the quotient Sine 97827 is $78^{\circ}.42^{\prime}$. which is the di-
stance of the meridian from the Horizon.

This done, I augment this quotient Sine 97827, by $\frac{1}{2}$
Sine of the complement of the reclination, which is 93041
the product 9101921967 I distribute by the whole Sine
and the quotient 91019 giveth an ark $65^{\circ}.32^{\prime}$. the
Elevation of the Peridian.

Now I add $65^{\circ}.32^{\prime}$ being the Elevation of the Pe-
ridian, to 52° . the Elevation of the Pole, and the totall
number $117^{\circ}.32^{\prime}$ being the compounded arke, because
it is greater than 90, I subtract it from 180. and there
remaineth $62^{\circ}.28^{\prime}$. which is the difference kept.

Afterward I multiply 88525 the Sine of the Comple-
ment repeated, by 88674 the Sine of the difference kept,
parting the product 7849865850 by the whole Sine. The
quotient is 78498 whole Ark is $51^{\circ}.42^{\prime}$. which is the
distance betwene the stile and the Substile.

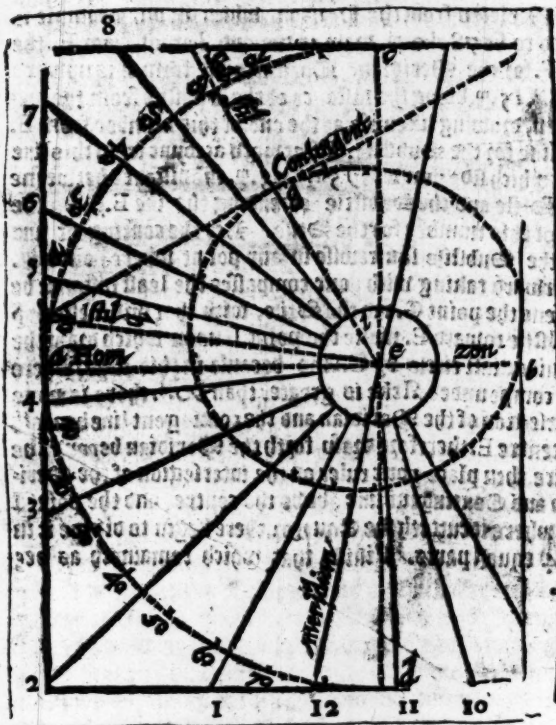
Then comparing the complement of this distance, being
 $38^{\circ}.17^{\prime}$. with the Complement of the difference kept,
which $127^{\circ}.32^{\prime}$. and finding this to be least, I amplifye
46226 the Sine thereof by the whole Sine, dividing the
product 4622500000 by the Sine of the greater, which is
61955 and 74612 the quotient coming hereof peeldeth an
arke $48^{\circ}.15^{\prime}$. whole Complement being $41^{\circ}.45^{\prime}$. I
take out of 180. and the remainder is $138^{\circ}.15^{\prime}$. the di-
stance of the Substile from the Peridian.

The delineation of the Figure.

First, as before, draw a line A.B. parallel to the Hori-

The Art of Dialling:

A North reclining declining.



The making of a South Inclining direct Dial.

CHAP. 16.

If the inclination of the plate be lesse than the Elevation of the Pole, take that from this, accounting the remainder for Elevation of the Pole. And with this number as if it were

The Art of Dialling.

Puttee in this Figure, that all the lines for the houres are
drawne opposite from the contingent line, beyond the cen-
tre E. In like manner must you doe in the delineation of all
such which incline more than the Elevation of the Pole.
Let the Diall in this kinde be placed directly over the
Meridian, with so great an angle as D.E.F. is ac.

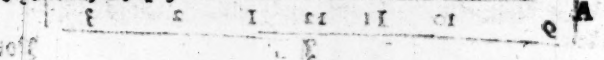
The making of a North inclining direct Diall.
Chap. 17.

If the Inclination of the place be lesse than the com-
plement of the Elevation of the Pole, adde the
Inclination to the Elevation; and with that
number, as if it were the Elevation of the Pole,
make a North erect Diall, for your place.

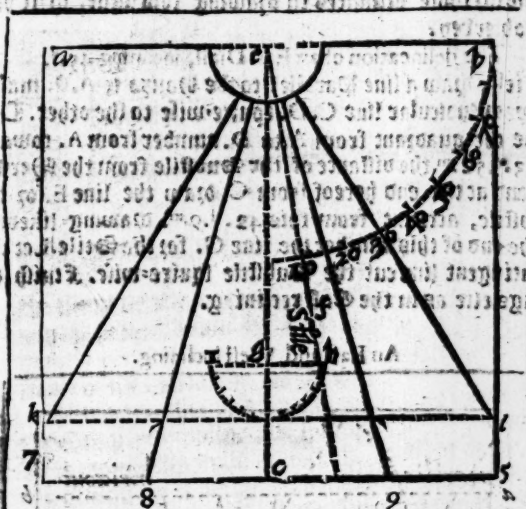
But if the Inclination be equall with the Complement
of the Elevation of the Pole, then make a Diall as you were
taught in the second kinde of South reclining direct; so as
that plate so reclining in the South is placed upward; so is
this plate downward. Note that this North Diall shew-
eth but onely foure houres, the two first in the morning and
the two last in the evening, and that onely in the midst of
Summer.

But if the Inclination be greater than the Complement
of the Elevation of the Pole, subtract this lesser out of the
other being greater; and with the number remaining, as
if it were the Elevation of the Pole, make your Diall like
to an Horizontall. This kinde likewise sheweth very few
houres.

Example of this last kinde, inclining 45° .
First I take 38° , being the Complement of the Ele-
vation of the Pole, out of 45° , the Inclination of the place, and
there remaineth 7° , which I keepe for the Elevation of
the Pole. For the delineation of this Diall, resort to the Ho-
rizontall, Chap. 3.



A North inclining Direct.



The making of the East and west inclining
Dials.

CHAP. 18.



Multiply the Sine of the Elevation of the Pole
by the Sine of the Inclination of the plat
dividing the product by the whole Sine: the
quotient arke shall be the distance of the Style
from the Sublie.

Then compare the Complement of this distance with
the Complement of the Elevation of the Pole, increasing
the Sine of the lesser by the whole Sine part the product by
the Sine of the greater, whereof shall come a Sine. the
Complement of whose arke shall be the distance of the Sub-
lie from the Perfor.

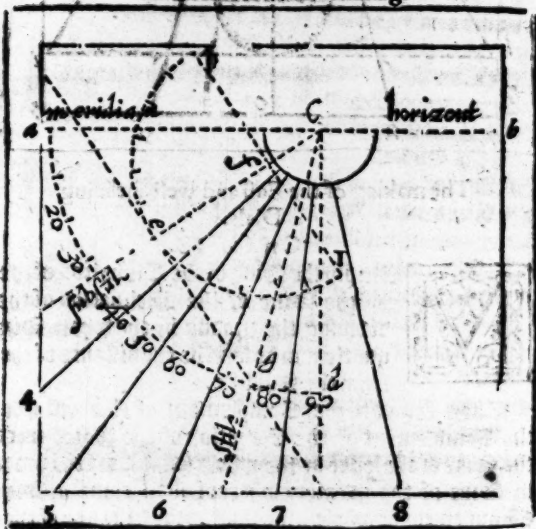
The Art of Dialling.

It shall not be necessary to shew any example hereof, because the East and West reclining bee altogether like unto this. Therefore resort thither, for the working of your example for those distances in dialling this figure shall bee here observed.

The delineation of an East Dial, inclining 45° .

First, draw a line Parallel to the Horizon, A.B. make the perpendicular line C.D. square-wise to the other. Describe the quadrant from A. to D. number from A. toward D. $33^{\circ} 43^{\circ}$. the distance of the Substile from the Perpendicular, and at the end hereof from C. draw the line E. for the Substile, account from this $42^{\circ} 9^{\circ}$. drawing likewise at the end of this number the line G. for the Stile. Let the Contingent line cut the Substile square-wise. Finish all things else as in the East reclining.

An East and West inclining.



The Art of Dialling.

31

The making of a South including
declining Diall.

CHAP. 19.



Rest, multiply the Sine of the Declination, by the Sine of the Complement of the Inclination, parting the product by the whole Sine. The quotient Sine shall be the whole Complement shall be named the Complement repeated.

Then increase the Sine of the Complement of the Declination by the whole Sine: and the product divide by the Sine of the Complement repeated: whereof shall come a Sine, whose arke is the distance of the Meridian from the Horizon.

Afterward, this Sine being multiplied by the Sine of the Complement of the Inclination, and the product parted by the whole Sine: the arke of the quotient Sine shall be the Elevation of the Meridian. Which arke you must add to the Elevation of the Pole. And if the totall number be less than 90. it shall be named the Doubtfull Arke. But if it be greater than 90. take it from 180, and let the remainder be called the Doubtfull Arke.

This done, augment the Sine of the Complement repeated, by the Sine of the doubtfull Arke: and the product arising thereof being divided by the whole Sine, the quotient Ark shall be the distance of the Style from the Substile.

Now compare the Complement of this distance, with the Complement of the Doubtfull Arke, multiplying the Sine of the lesser, by the whole Sine, dividing the product by the Sine of the greater: the Arke of the quotient Sine

The Art of Dialling.

coming thereof shall be the distance of the Substile from the Meridian.

But note, if the doubtfull arke be found without subtraction from 180, (which is if it be lesse than 90. ^d then you must subtract the distance of the Substile from the Meridian out of 180. and the number remaining, shall be the true distance of the Meridian from the Substile.

Marke this likewise if the doubtfull arke be equall 90. degrees let the Complement repeated be the distance of the Style from the Substile: then shall there be still 90. for the space between the Substile and the Meridian, as before is taught in the 12th of Dialling reckoning, to which you may resort for the working thereof. Here I shall be content to shew two examples, with the destination of their figures: for one, where the doubtfull arke is increased from 180. ^d and the other, where there is no subtraction thereof, because it is lesse than 90. degrees.

Example of a South Dial Declining 45. degrees.

Declining 45. degrees.

Forasmuch as this is altogether like to the 12th reckoning 45. Declining 45. whether you may resort to without the working of the former part of this example, until it come to be a rising but of the distance of the Substile from the Meridian. The former part of this example you may find to be thus wrought in the 12th reckoning begun at 6. First the Complement repeated 90.

Then the distance of the Meridian to the Horizon 54. 44. ^m.

Next the Elevation of the Meridian 35. ^d 16. ^m.

The compounded Arke there, which we call the doubtfull Arke here 87. ^d 16. ^m.

The distance of the Style from the Substile 17. ^d 4. ^m.

Last the distance of the Substile from the Meridian 84. ^d 33. ^m.

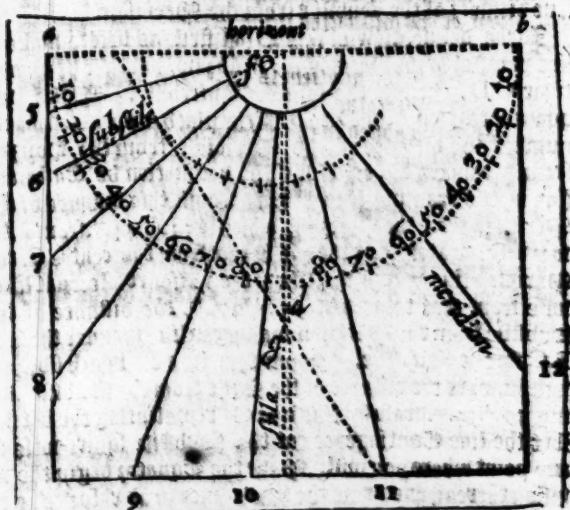
But here (as before is taught) you must subtract this distance from 180° , because the doubtful Arke was less than 90° , and then the remainder $95^{\circ} 27'$ shall be the true distance of the Substile from the Meridian.

In the delineation of this Dial first, as before make a line parallel to the Horizon A. B. Draw another perpendicular C. D. cutting the former squarewise. Make two quadrants from A. by D. to B. If the place decline Westward, number the distance of the Meridian from the Horizon from A. toward D. &c. But if the declination be Eastward (as in this example it is) then account this distance of the Meridian from the Horizon, which is $54^{\circ} 44'$ from B. toward D. drawing at the end hereof from the centre C. the Meridian line which shall shew the 12 hours. Account likewise from that toward A. $95^{\circ} 27'$ the distance of the Substile from the Meridian-making in like manner the line E. C. for the Substile. From this line on which side you will number the distance of the Style from the Substile being $59^{\circ} 54'$ draw by this line G. representing the Style. Let the line Contingence cut the Substile squarewise in any point where you will. Make the Equator begin the division thereof, and draw the houre lines in all respects as in the former declining $21^{\circ} 5'$ declining 30° Chap. 15.

South

The Art of Dialling.

A South declining Inclining Dial.



The second example of a South Dial. } Inclining $33^{\circ} 44'$ } Where the double-
Declining 31° } full Arke is sub-
tracted from 180 .

First, 51503 the Signe of the Declination being multiplied, by 83237 the Signe of the Complement of the inclination; and the product 4286440181 , divided by the whole Sign; the Ark of the quotient is $25^{\circ} 23'$. The Complement whereof being $64^{\circ} 37'$, is the complement repeated.

Then I increase the Signe of the Complement of the declination, which is 85716 , by the whole Sign, and I part the product 8571600000 , by 90346 . The Signe of the Complement repeated. The quotient 94875 pointing an Arke, 71° .

71.^d.35.^m. which is the distance of the Meridian from the Horizon.

Again, I multiply this Sign 94875. by the Sign of the Complement of the inclination being 83227, and the product 7895961425 arising thereof, I divide by the whole Sign. The Ark of the quotient is 52.^d.9.^m. which is the Elevation of the Meridian.

Now this being added to the Elevation of the pole 52.^d and the to all number 104.^d.9.^m. taken from 180 there remaineth 75.^d.51.^m. which is the doubtfull Ark.

Therefore I augment 90346 the Sign of the Complement repeated, by 96930 the Sign of the doubtfull ark and the product 8760399890 I part by the whole Sign. The Ark of the quotient 61.^d.10.^m. is the distance of the Substile from the stile.

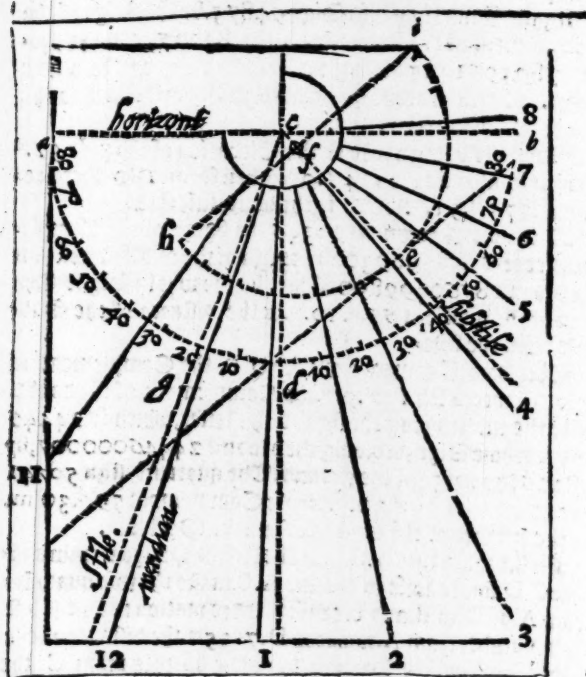
This done, I compare, 28.^d.50.^m. the Complement of this distance, with 14.^d.9.^m. the Complement of the doubtfull arks, multiplying the sign of the lesser, which is 24446 by the whole Sign, dividing the product 24446000007, by 48226 the Sign of the greater. The quotient sign 50741 yeildeth an ark 30.^d.30.^m. whose Complement 59.^d.30.^m. is the distance of the Substile from the Meridian.

First, draw a line A.B. Parallel to the Horizon draw another C.D. squire-wise to the line A. B. make the two quadrants from A. by D. to B. and because this declination is on the left hand number from A. towards D. 73 5.^m. the distance of the Meridian from the Horizon, drawing by this from C. the Meridian line. From that toward B. account 59.^d.30.^m. the distance of the Substile from the Meridian, making in like manner at the end of the number from C. the Substile line E. Again from this toward (if you can, or else backward) number the distance of the stile from the Substile, which is 61.^d.10.^m. draw likewise by this from C. the line G. for the stile. Let the contingent cut the Substile squire-wise in any place, where you will, &c. The making of the reclining declining Dial before, shall teach you the finishing of this likewise.

The delineation of the figure

The Art of Dialling.

A South declining inclining.



The making of a North inclining declining Dial.

CHAP. 20.

The working of this kinde is altogether like the South reclining declining Dial. First, therefore multiply the Sine of the Declination, by the Sine of the Complement of the Inclination dividing the product by the whole Sine. The quotient shall give an Arkenshole Complement.

plemett shall be named the Complement repeated.

Then augment the Sine of the Complement of the declination by the whole Sine, and the product part by the Sine of the Complement repeated. Whereof will come a quotient Sine; whose arke shall be the distance of that which is as it were the meridian from the horizon.

For the finding of the elevation of the Meridian, because it may be done two sundry wayes, I will let them down both, referring the choyce to your selfe.

<p>Compare the Complement of the Arke last found out, with the Declination of the plat, multiplying the Sine of the lesser, by the whole Sine; and dividing the product by the Sine of the greater. The quotient Sine shall yield an Arke whose Complement shall be the Elevation of the Meridian.</p>	<p>Or multiply the Sine of the arke last found out by the Sine of the Complement of the inclination, part the product by the whole Sine; and the Arke of the quotient Sine shall be the elevation of the Meridian.</p>
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Now comparing the Elevation of the Pole with the Elevation the Meridian, subtract the lesser from the greater, retaining the number remaining, which shall be called the difference kept.

Afterward increase the Sine of the difference kept, by the Sine of the Complement repeated, and divide the product by the whole Sine. The quotient arising of this division shall give an arke, which shall be the distance between the stile and the substile.

To conclude, the Complement of this distance being compared with the Complement of the difference kept, multiply the Sine of the lesser by the whole Sine, and part the product by the Sine of the greater. The Complement of the Arke of the quotient Sine, shall be the distance of the Substile from the Meridian.

But note, if the Elevation of the Meridian, and the Elevation of the Pole be found equall, make an Equinoctiall

The Art of Dialling.

Diall, as before you were taught in the Perditionall rectifying declining: for there is no difference, but onely that this is placed both newward, and the South upward.

There be of this North, as of the South reclining declining, three sundry kinds of Dialls, as by the examples and figures following you may perceiue.

First Example, Example of a North Diall } Inclining 20° .
Declining 30° .

First, I multiply 50000 the Signe of the Declination by 93969 the Signe of the Complement of the Inclination and the product thereof 4698450000. I diuide by the whole Signe 100000, and the quotient Signe 46984 yeeldeth an Ark $28^{\circ} 2^{\circ}$ whole Complement $61^{\circ} 58^{\circ}$ is the Complement repeated.

Then I augment the Signe of the Complement of the Declination, which is 86602 by the whole Signe, parting the product 8660200000, by 88267 the Signe of the Complement repeated: the quotient is 98113. The Ark thereof being $78^{\circ} 51^{\circ}$ is the distance of the Peridian from the Horizon.

Two waies in working the example, for the two precepts of the finding out the Elevation of the Meridian.

Both these tend to one end.

Now in comparing the Complement of the Arke last found out, with the declination of the plat: I find the Complement of the arke least. Wherefore I multiply the Sine thereof being 19337 by the whole Sine: and the product 1933700000, I diuide by 50000 the Sine of the greater. The quotient 38673 giueth an ark $22^{\circ} 46^{\circ}$ whole Complement $67^{\circ} 14^{\circ}$ is the Elevation of the Peridian.

This done, I compare the Elevation of the Peridian $67^{\circ} 14^{\circ}$ with the Elevation of the Pole 52° . Subtracting the lesser from the greater, and there remaineth $15^{\circ} 14^{\circ}$. which is the difference kept.

Or multiply 98112 the Sine of the arke last found out, by the Sine of the Complement of the Inclination, which is 93969: and the product 9219596568 part by the whole Sine. The quotient shall bee 92192, whole Ark 67 degrees 14 minutes is the Elevation of the Peridian.

Then

The Art of Dialling. 35

Then I multiply 26275 the Sine of the difference kept by 88267 the Sine of the Complement repeated: parting the product 2318455682. by the whole Sine. The Arke 11.^d.47.^m. of the quotient Sign 23184, is the distance of the stile from the Substile.

Now the Complement of this distance being 76.^d.36.^m. compared with 74.^d.47.^m. the Complement of the difference kept, I increase 96494 the Sign of the lesser, by 5 whole Sign and 5 product thereof 9649400000, I distribute by 97277 the Sign of the greater. And the quotient is 99191, whose Ark is 82.^d.43.^m. The Complement where of being 7.^d.17.^m. is the distance of the Substile from the Peridian.

The delineation of the Diall;

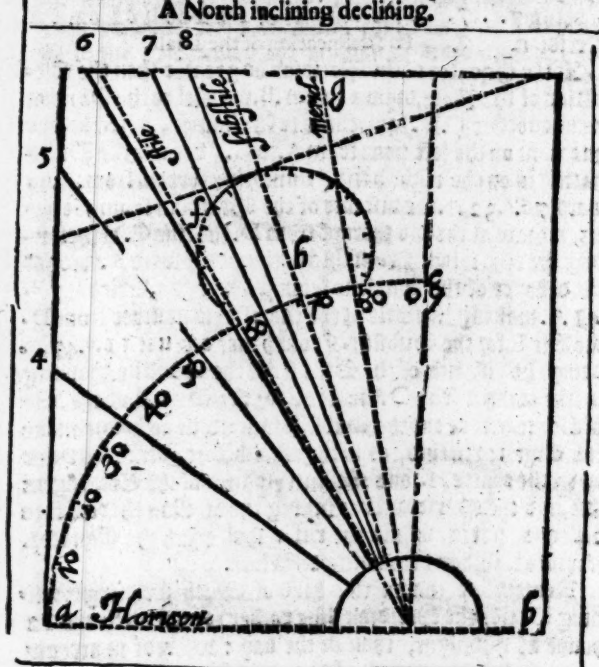
If the Equator of the Peridian be greater then the Elevation of the Pole, draw a line A.B. parallel to the Horizon make another C.D. squarewise to the former, describe the quadrant on the left hand from A. to C. (because the Declination is on the right hand) numbring therein from A. upward 76.^d.32.^m. the distance of the Peridian from the horizon, draw at the end thereof from D. the line C. representing the Peridian. From this backward toward A. account the distance of the Substile from 5 Peridian, which is 7.^d.41.^m. making likewise at the end of this number from D. the line E. for the Substile. From hence account 11.^d.47.^m. being the distance of the stile from the Substile, drawing in like manner from D. the line F. for the stile. Let the line of Contingence out the Substile squarewise as before, make the Equator in this, as in the other before. Place the ruler upon the centre H. and the intersection of the Contingent line, and the Peridian, beginning the division thereof into 24 equal parts, where the ruler shall touch the Equator. Finish all things remaining as before.

Remember that in this kind of North inclining declining Diall, the Peridian line rather representeth the 12. houre at midnight, than in the day: whereof in accounting

The Art of Dialling:

ting the houre lines, let the Meridian be alwayes for the 12 houre in the night. And then if your plat decline Westward account backward as it were 11. 10. 9. which houres wit the 12 you may omit in the delineation of your Diall. because they have no use in our Elevation. But account forward 8. 7. 6. 5. 4. &c. so many as you think shall be necessary for some declination will receive more, than other will: the greater the more, the lesser the fewer houres. But if the declination of the plat be Eastward, then account from the Meridian line forward 1. 2. 3. 4. &c. so many as shall be needfull, omitting likewise the first three, &c.

A North inclining declining.



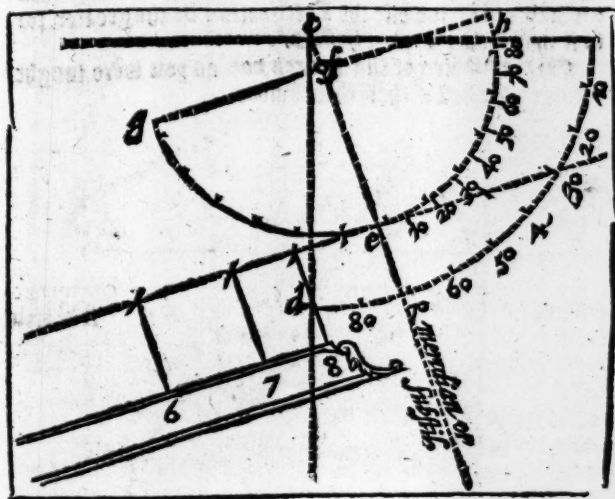
The

The Art of Dialling. 36

The second kinde.

But if the Elevation of the Peridian, and the Elevation of the Pole be equal, the making of the Diall differeth from the other before. For an example he: sol, and the drawing of the Figure, resort to the South reclining $33^{\circ} 30^m$ declining 32° . for these are both alike, onely remember here that if this decline Eastward, make the quadrant likewise on the East side, &c. But if the plate decline toward the West, make the quadrant Westward (as in the Figure following) finishing all things else as here you see done. Observe the same order in naming the hours lines which I taught you before.

A North inclining declining.



The

The Art of Dialling.

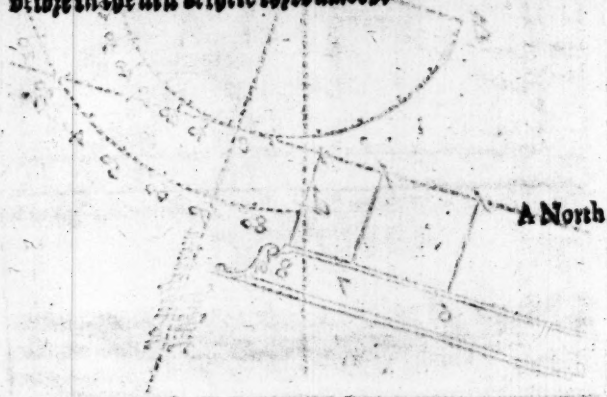
The third Example of a S Inclining 45.^d.
North Dial. 2 Declining 45.^d.

If the Elevation of the Peridian be lesser than the Elevation of the Pole, make your Dial thus,

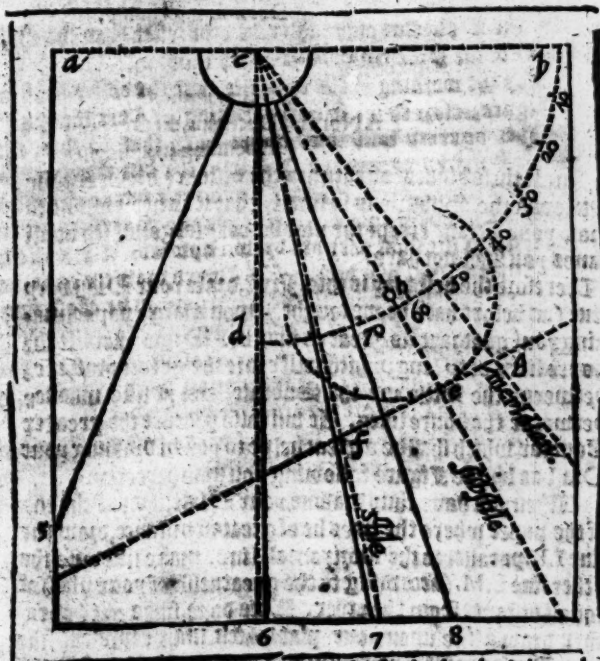
For the working of the example, and the delineation of 3 figures, referre to the South reclining 45.^d. declining 45.^d for that agreeth with this, excepte onely that in this, the stile is placed downward, and sheweth but few houres, and those likewise are drawn downward: but in the other the stile standeth upward, shewing many houres, and those likewise for the most part are drawn upward. Mark also in this kinde, if your plat decline Westward, draw the quadrant on the West side, but, if the Declination be Eastward, make the quadrant on the East side, &c.

The making of these, are more pleasant to know, than profitable to use: unless the Declination be the greater, for so it may shew the more houres.

For the naming of the houres, doe as you were taught before in the first of these three kindes.



A North Declining Inclining.



The delineation of those Dials, whose plat lyeth nigh to the Elevation of the Pole.

CHAP. XI.

WHEN the declination and inclination, or declination, and inclination, shall cause the plat of your Dial to lie nigh to the Elevation of the Pole, then the houre lines must be drawne very long to make the distances somewhat large, so that they may be distinguished one from another. And

common.

The Art of Dialling.

commonly these following be such as here we meane.

A South } Reclining direct.
Declining erect.
Declining reclining.

An East or West } Reclining.
Inclining.

A North } Inclining direct.
Declining erect.
Declining inclining.

In all these kindes oftentimes the distance betwene the stile and the Substile is so small, that it is not possible to draw your Diall, except the plat be very large: which at all times you shall not dare.

Therefore the best way is this. First, draw your Diall very true (as before hath been taught) upon a large paper, making your quadrant as great as may be. Draw likewise the houre lines very long, which will cause the greater distance betwene the stile and the Substile, and in like manner betwene the houre lines. It will also procure the greater Equator, which shall be a great helpe to you in drawing your Diall, as by the Figure following you may perceive.

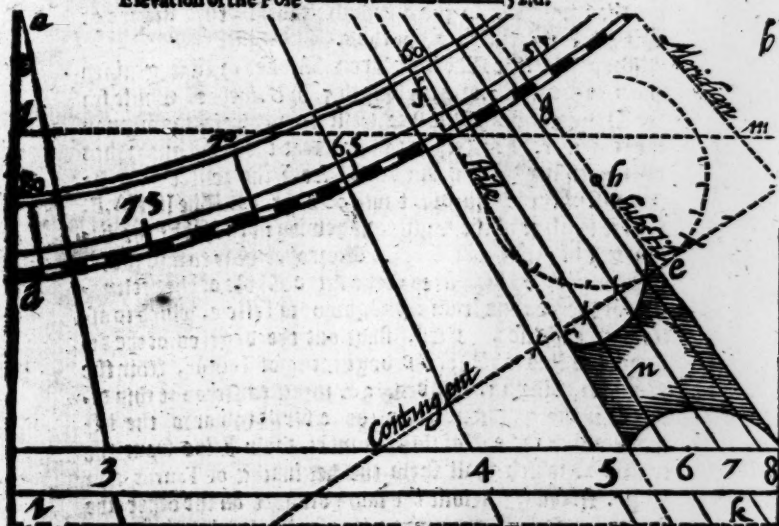
When you have thus drawne your Diall, then at the end of the paper where the lines be of greatest distance, draw the line I.K. parallel to the Horizontall line, make likewise the other line L.M. (according to the greatnesse of your plat) of equall distance from the other. This done, find out (or rather draw a line upon your plat which may represent) the true Horizon of the place, cutting the paper in twise by the line I.K. and the line L.M. placing it upon your plat very plain, so that one of the edges may be parallel to the Horizon. When make markes upon the plat at both ends of all the houre lines, drawing by those markes, the lines for the houres. Draw likewise light lines upon the plat for the stile and the Substile, easily to be distinguished, as you did upon the paper.

Let the stile N. be fastened over the Substile, as you have before

beene taught in the East, and West, or Equinoctiall Diall.
 But here note, that the Stile must not be of equal height
 at both ends. But let it be so high, as the distance betweene
 the Stile and the Substile is in the place where it standeth,
 as in the examples following you may plainly perceiue.

A North Diall.

Declining Westward ————— 65 d.
 Inclining ————— 22. d. 10 m.
 Distance of the Meridian from the Horizon — 50. d. 10 m.
 Distance of the Substile and the Meridian — 6. d. 35 m.
 Distance of the Stile and Substile — 4. d. 15 m.
 Elevation of the Pole ————— 52. d.



Hitherto we have taught the destination of all kinds of
 Dialls, which are to be made upon any plaine plate or super-
 ficies now followeth the garnishing of them, with the 12
 Signes and the houres unequall.

I. 2

How

The Art of Dialling.

How to draw the 12. Signes in all kind of Dials
before mentioned.

CHAP. 22.

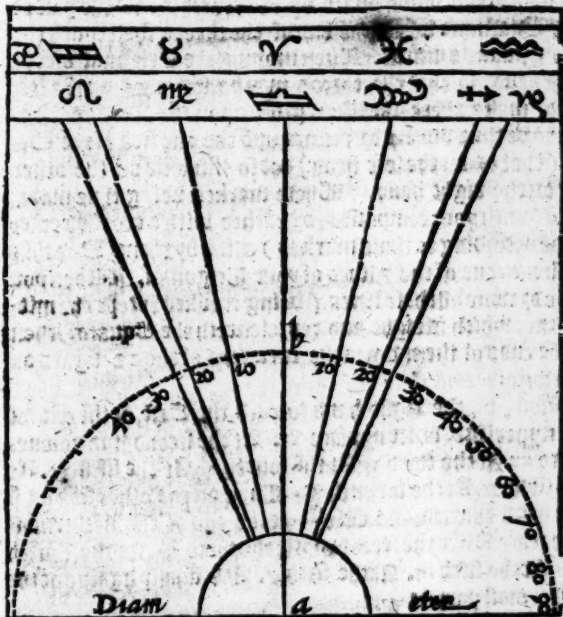


Asomuch as sometime the 12. Signes of the Zodiake are placed in Sunne Dials, to know in what sign the Sunne is at any time (which albeit any kinde will receive, yet most commonly the vertical directly opposite to the South are garnished therewith:) Therefore in drawing the 12. signes, in these South, and all other kindes of Dials before mentioned, doethus.

Prepare a little Table of Iron, Brasse, or close grained wood, in breadth 3. or 4. in length 5. or 6. inches. Chuse for the Diameter one of the shortest Boes, wherein draw upon the centre A. halfe a circle to be divided into two quadrants distinguishing with a line drawn from the centre A. to the Arke B. part each quadrant into 90 degrees. The line A. B. is here in place of the Equator, shewing in the Arke the beginning of Aries and Libra. Moreover how to find the other Signes on both sides, seeke in the Table of the declination of the Sunne from the Equinoctiall circle, which is afterward expressed. First, finde out the degrees of the distance (in this table) of the beginning of Taurus, from the Equator, being 11. degrees, 30. minutes. Account this distance in the quadrant from the letter B. towards the left hand and at the end of this number draw a line from the centre A. which shall shew the beginning of Taurus and Virgo. Account likewise the same distance on the other side from the line A. B. and make a line for the beginning of Pisces and Scorpius. Again in the 20.^d, 12.^m. from the line A. B. you shall have the beginning of Gemini and Leo and so many degrees and minutes on the other side, the beginning of

of Aquarius and Sagittarius. To conclude on both sides in the 23. degrees 30. minutes, there must be on the one part Cancer and on the other Capricorne.

Afterward draw lines from the centre A. by every marke so long as your Table will receive: and at the end of these lines let the characters of the 12. signes of the Zodiack be fixed: as in the figure following you may see.



The Art of Dialling.

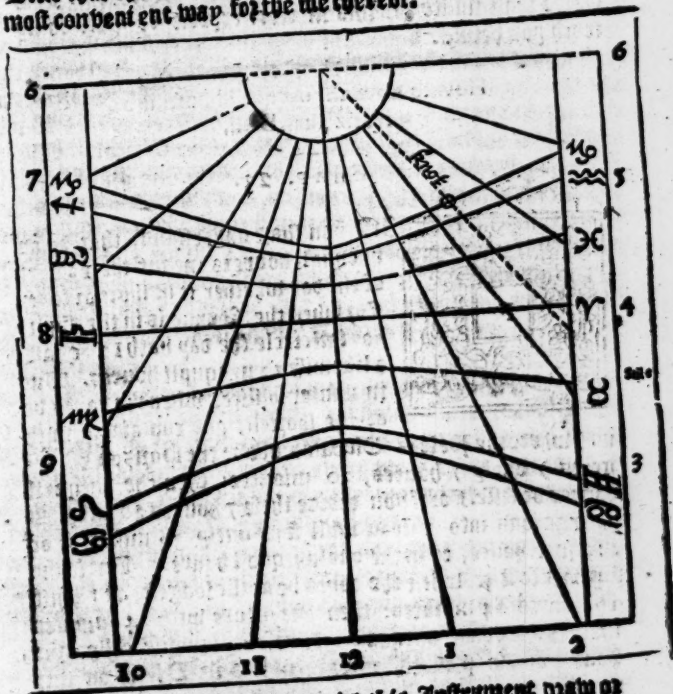
Your Diall being made, and the Stile placed therein take your Trigonall Instrument, and set it upon the Stile, so that the whole Diameter thereof may stand p'aine upon the edge of upper part, the centre A. of your Instrument alwayes remaining in one place of the Stile. Let the line S bend upward to the centre of your Diall, and the line of \vee downeward. Then fasten a thread at the uppermost end of your Trigonall in every line of the signes, so þ you may direct downeward by the centre A. to the plat of your Diall and when the end of the thread shall touch the Diall, make a marke. Then moving the Trigonall on the right hand, so that the thread may be stretched on the left hand, make there likewise a pick upon the plat. When you have thus done 4 or 5 times up the one side of the Diall (that is on the left hand) doe so likewise on the other side on the right hand. These markes being thus made, draw (with your compasses, or rather with a crooked ruler made according to those markes) a line by them. Doe thus with each one of the 7 lines of your Trigonall. When you have drawne all these lines, (being crooked except the middle line, which is right, and representeth the Equator) then at the ends of them write the characters of the 12 signes on this wise.

First, on the right hand toward the East, at the end of the upper line, write of place \vee . At the second line downeward ∞ . At the third \times . At the fourth γ . At the fifth δ . At the sixth Π . At the seventh S. Then on the other side on þ left hand toward the West, at the end of the uppermost line place S. At the second α . At the third η . At the fourth ϵ . At the fifth m . At the sixth z . And finally againe at the uppermost part let \vee .

This done, remember that in what place of the stile the centre

The Art of Dialling. 40

centre A. of your Triggonall was placed, there fasten a small piece of Iron or any such like thing, which may shew with it shadow thereof, the Signe which the Sonne shall be in at any time: unless the houre lines be so short, that where the small peice of Iron should be placed, you may cut the stile that the end thereof shall shew it. But the first is the most convenient way for the use thereof.



You may in like manner with this Instrument draw or place the 12 signes in Horizontall East, West, and all other times of Diall, which before are rectified because the difference

The Art of Dialling.

difference is nothing but in placing the 12 signes at the ends of the lines: the true doing whereof, you may easily perceive by the course of the Sunne. For in the South Erect, when the Sunne occupieth Cancer, the 12 is the line of furthest distance from the centre of the Diall. But in the Horizontall Diall, the line of 6 is next to the centre. Few words shall suffice for this matter: experience shall easily teach you herein.

How to place the unequal hours in a Horizontall Diall,

CHAP. 23.



First you shall understand, that by an unequal hour is meant the 12 part of the day whether it be short or long. For when the Sunne is in the Equinoctiall circle, the day hath 12 equal, & likewise 12 unequal hours. But in winter solstice, when the dayes be at the shortest, and containeth with us (where the Pole is Elevated above the Horizon 58 degrees) onely 7 houres, 30 minutes: then the unequal hours be lesse. For if you divide these 7 houres 30 minutes by fractions into 12: you shall find onely 38 minutes of an equal hour, to make one unequal hour. But in the summer solstice, when the dayes be at the longest, and hath 16 houres 14 minutes: then one hour with 14 minutes maketh one hour unequal. These be likewise called the houres of the planets, and are placed in Dialls on this manner.

Your Diall being made and prepared, when upon it the 12 signes of the Zodiacke (as you were taught before) in large in your plat will give you leave, &c.

Note that a wayes the Persian line of 12 equal hours is

The Art of Dialling. 41

is the 6 vnequall houre. Marke likewise, that when the Sunne entred into the beginning of γ and α , both the equall and vnequall houre be of like quantity. For the 7 equall houre in the morning is the first vnequall, and the 8 equall the second planetary houre, &c.

But in the Tropike of \S it is otherwise: for then the vnequall houre be greater then the equall. Therefore account how many houre and minutes is in the longest day for your Elevation; changing all the minutes of those houre into one coroll forme. Then diuide this number by 12: and the quotient shall shew how many minutes of an equall maketh one vnequall houre. Example hereof with us the longest day is 16 houre 24 minutes. Wherefore I multiply 60 which is the minutes of an equall houre, by 16 which is the summe of houre of the longest day, and the product ariseth to 960, whereunto I adde 24 minutes remaining, then the number shall be 984, which being diuided by 12 the quotient is 82. Wherefore I conclude that 82.^m of an equall, maketh one vnequall of planetare houre. Then to draw them in Dialls, worke thus.

First, in the Tropike of \S diuide the space betwene each houre into 60 equall parts, but because those distances bee so small for the most part, that this cannot be done: therefore it shall suffice to diuide every one of them into three equall parts. Then shall every part containe 20.^m and three of them 60.^m which is one equall houre.

When as therefore you will place the 7 vnequall houre, account from the Meridian line, of the houre, 4 parts and 2 minutes (which is 82 minutes) and make there a marke. Then place your ruler by this point of marke, and the intersection of the line of γ and α , and the first houre after noone: draw a line from one Tropike to another, that is from \S to γ .

Then for the placing of the 8 vnequall houre, account from the 7 last made, 4 of the foresaid parts and two minutes; make there a marke, by which and the intersection of

The Art of Dialling.

the line of γ and Δ and the line of the second houre after
noon, the ruler being placed upon a line, as before.

For the 2 account from the 8 last made, likewise 4 parts
and two minutes, drawing a line as before. Do in like
manner for the drawing of all the other remainings: that is,
for the 10 and 12. The 12 being the Sunne setting, shall
need no line.

As you have finished the unequal houre on this line for
the afternoon, doe in like manner for those in the forenoon
accounting from the Perpetual 4 parts and 2 minutes, to each unequal
houre, to each unequal, drawing, as before, lines from one
Equiptic to another.

Then may place the figures for the unequal of planetary
houres, at the end of the lines under the Tropique of Capricorne,
or where the line of Cancer may be will, as is shown.

Note that the same part of the Diall which belongeth to
the 12 figure, shall likewise serve the unequal houre, as
better understanding hereof.

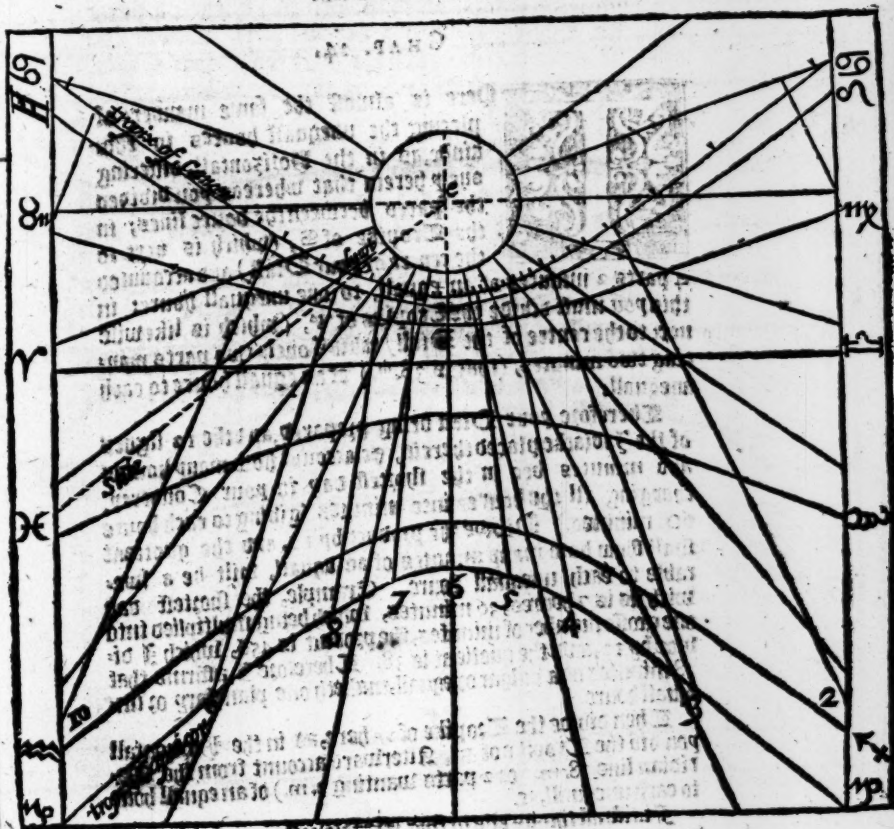
Behold the Figure following.

AH

The Art of Dialling.

42

An Horizontal Dial,
and Sundial



How to draw a Dial
on a Wall

The Art of Dialling

How to place the houres unequal in a South
erect direct Dial.

CHAP. 34.



Here is almost the same manner of placing the unequal houres in this kinde, as in the Horizontall, differing onely herein, that whereas you divided the spaces between the houre lines, in the Tropike of S , (which is next to the centre of your Dial) and accounted 2 parts 2 minutes of an equall to one unequal houre: in this you must divide the Tropike of v , (which is likewise next to the centre of the Dial) taking onely two parts wanting two minutes, (that is 38^{m}) of an equall houre to each unequal.

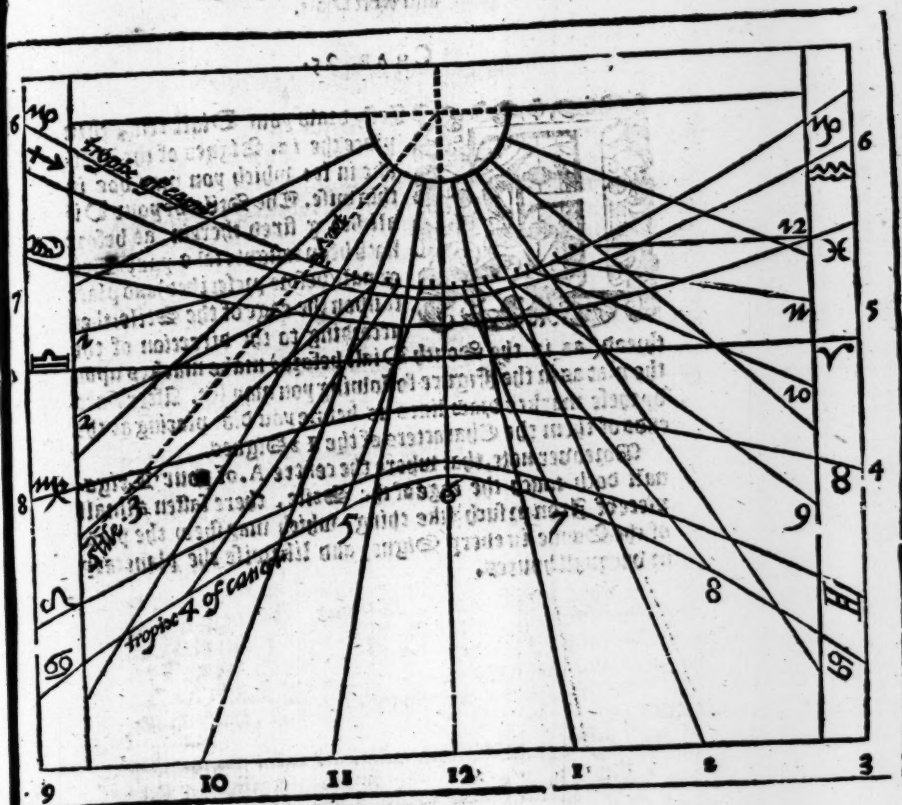
Therefore your Dial being prepared, and the 12 signes of the Zodiacke placed therein, so account how many houres and minutes bee in the shortest day in your Countrey, changing all the houres into minutes (giving to each houre 60. minutes.) Divide the product by 12, and the quotient shall shew how many minutes of an equall, will be answerable to each unequal houre. Example, the shortest day here grows number of minutes, the product is 456, which I divide by 12, and the quotient is 38. Therefore I assume that 38 minutes of a vulgar or equall, maketh one planetary or unequal houre.

Then divide the Tropike of v here, as in the Horizontall you did the Tropike of S . Afterward account from the Meridian line 38^{m} (or 2 parts wanting 2. m.) of an equall houre to each unequal, &c.

Finish all things else in this Spherical erect direct, as you were taught in the Horizontall. The Figure ensueth.

A South

A South Dial.



The

The Art of Dialling.

The placing of the houres unequal in east
and west Dials.

CHAP. 25.

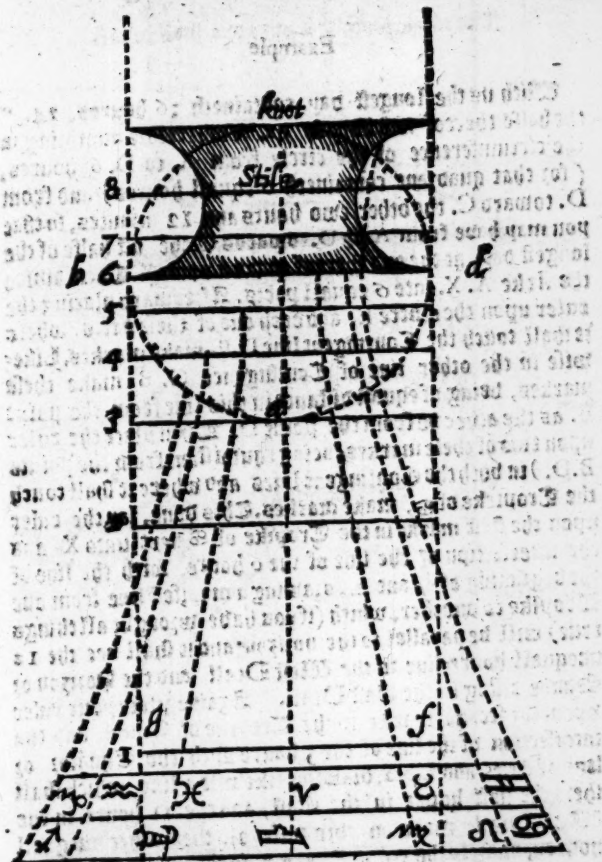


First, draw your Dial true, then place the 12. Signes of the Zodiacke in it: which you may doe in this wise. The Centre of your Dial being first therein, as before hath been taught, take your Trigonal (before prescribed) and place it upon the edge of the Dial: then according to the direction of the thread, as in the fourth Dial before, make marks upon the plate as in the figure following you may see. Afterward by these marks draw lines as before you did, placing at the ends of them the Characters of the 12. Signes.

Whereover note, that where the centre A. of your Trigonal doth touch the edge of the Dial, there fasten a small piece of Iron or such like thing, which may shew the place of the Sunne in every Signe, and likewise the planetary or unequal houres.

E 2 I XI II OI 2

When



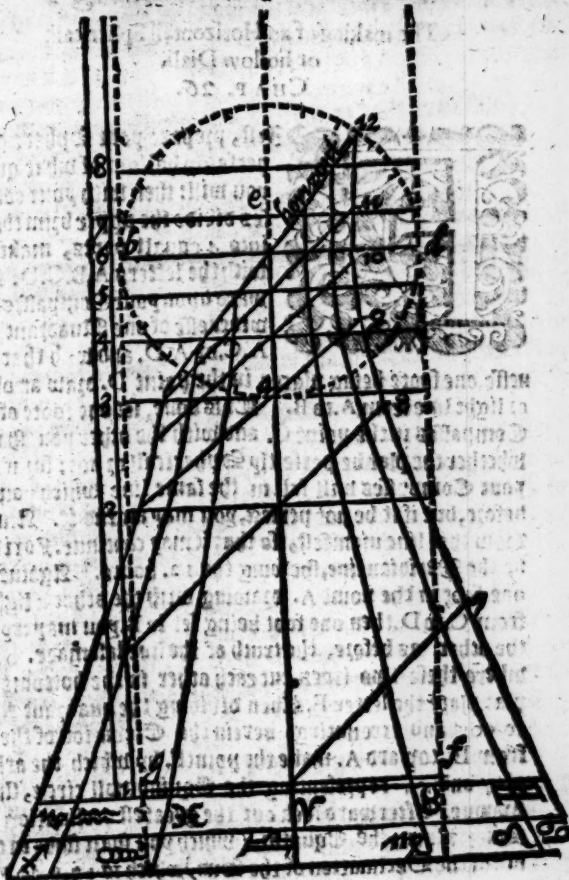
When as therefore you would place the houres unequal in those kinds of Dials, account the number of houres and minutes, which the halfe of the longest day in your Country both contains.

Example

The Art of Dialling.

Example

Which is the longest day containeth 16 houres, 24. ^m. the halfe thereof is 8 houres 12. ^m. wherefore numbring in the circumference of the circle from A. to D. 6 houres, (for that quadrant containeth 6 equall houres) and from D. toward C. the other two houres and 12 minutes, so that you may have from A. by D. toward C. the full halfe of the longest day, at the end thereof make a point X. Then divide the Arke A. X. into 6 equall parts. Afterward placing the ruler upon the centre E. and each one of these parts, where it shall touch the Contingent line D. F. make markes. Likewise in the other line of Contingence G. B. make these markes, being of equall distance in this line from the point B. as the other be from the point D. Then place the ruler upon two of these markes, being equidistant from the points B. D.) in both the Contingent lines, and where it shall touch the Tropike of φ . make markes. This done, lay the ruler upon the first marke in the Tropike of Sagitt. unto X. and the intersection of the line of the 6 houre, with the line of the beginning of γ and α . drawing a manifest line from one Tropike to another, which (if you have wrought all things true) will be parallel to the horizon; and it shall bee the 12 unequall houre-line in the West Diall, and the Horizon of Sunne rising in the East Diall. Again, place your ruler upon the second marke in the Tropike of Cancer, and the intersection of the line of the 5 houre with the Equator or line of Aries and Libra, drawing likewise a line, which shall shew the first houre in the East, and the 11 houre in the West Diall; make on this wise all the other unquall houres, namelysthe 10, 9, 8. and 7, in the West Diall. And the 3, 4, 5, in the East Diall.



The

N

The Art of Dialling.

The making of an Horizontall Spherical,
or hollow Diall.

CHAP. 26.



First, prepare your Sphere or plat perfectly hollow, of what quantity you will: then with your compasses divide the upper brym thereof, into 4 equal parts, making it with the letters A, B, C, D. After, sett upon your Compasses to the wideth of one Quadrant, either A, C, or A, D, and with that wideth, one foot being placed in the point D, draw an oblique or light line from A to B. Then sett the one foot of your Compasses in the point C, and with the other you shall try whether the plat be perfectly Spherical or not: for if it be, your Compasses will fall in the same line which you made before, but if it be not perfect, you may amend it. And then draw this line manifest, so that it may continue. For it shall be the Meridian line, shewing the 12. hours. Again place one foot in the point A, drawing with the other a light line from C to D, then one foot being set in B, you may try with the other, as before, the truth of the line continuance. Now where these two lines cut each other in the bottom of the plat place the letter E. Then dividing the quadrant A, E, into 90.°, and accounting therein the Elevation of the Pole from E toward A, make the point F, to which the arke line representing the Equinoctiall circle, shall be drawn. Afterward look out the greatest declination of the Sunne from the Equator, (which you shall find in the table of the Declination of the Sun) which is 23.°. 30.ʳ. The account 23.°. 30.ʳ. from F. toward E. making there a marke for the arke of Cancer. Likewise from F. toward A. number the same distance for the arke line of Capricorn. This done, account from F. toward E. 20.°. 12.ʳ. make there also a mark

for the line π and η . And the like space from F. towards A. for the Arke of π and η . To conclude, number from E. towards E. 11. 4. 30. making there also a marke for the line of π and η and so much from F. toward A. for π and η .

When you have thus made markes for all the Arkes of the 12 Signes, open your Compasse to the Diameter of the Sphere that is from A. to C. with the wideneſſe of the Compasse remaining, place one foot in the point F. in the Arke of π and η in the Meridian: and where the other foot shall touch the same Meridian towards B. make the point G. which shall represent the Pole Antartike, by which, as it were from a centre, draw a line from the point D. by F. to C. which shall be the line of Aries and Libra. Then one foote of your Compasse remaining in the point G. with the other draw lines from one foot at the place to the other, by every marke before made for the 12 Signes of Zodiacke.

The 12 Signes being thus finished, proceede to the division of the equall houres on this manner. Divide the Arke of the Equator into 12 equal parts, beginning at D. by E. ending in C. Then open your compasse to the Diameter of the plat, and the same wideneſſe of them remaining, draw one foot on the first point of the division next C. in the Equator, and if you have divided the Equator equally, the other foot will touch the first part beyond F. towards D. by which from the centre G. to the edge of the plat, draw a line, which shall show the first houre afternoone. This done, reſet your Compasse (that wideneſſe remaining) placing one foote in the second part from C. towards F. and the other foote touching the second part from F. towards D. draw a line as before from the centre G. to the byſſime of the plat, so shall be the second houre afternoone. In the same manner finish all the other houre lines, namely the 3. 4. 5. 6. 7. 8. 9. the afternoone. Then doe likewise on the other ſide for the houres in the forenoone, namely the 11. 10. 9. 8. 7. 6. 5. and 4 drawing lines from the centre G. by every division, to the byſſime of the plat, &c.

The Art of Dialling.

The placing of the unequal houres in this Dial.

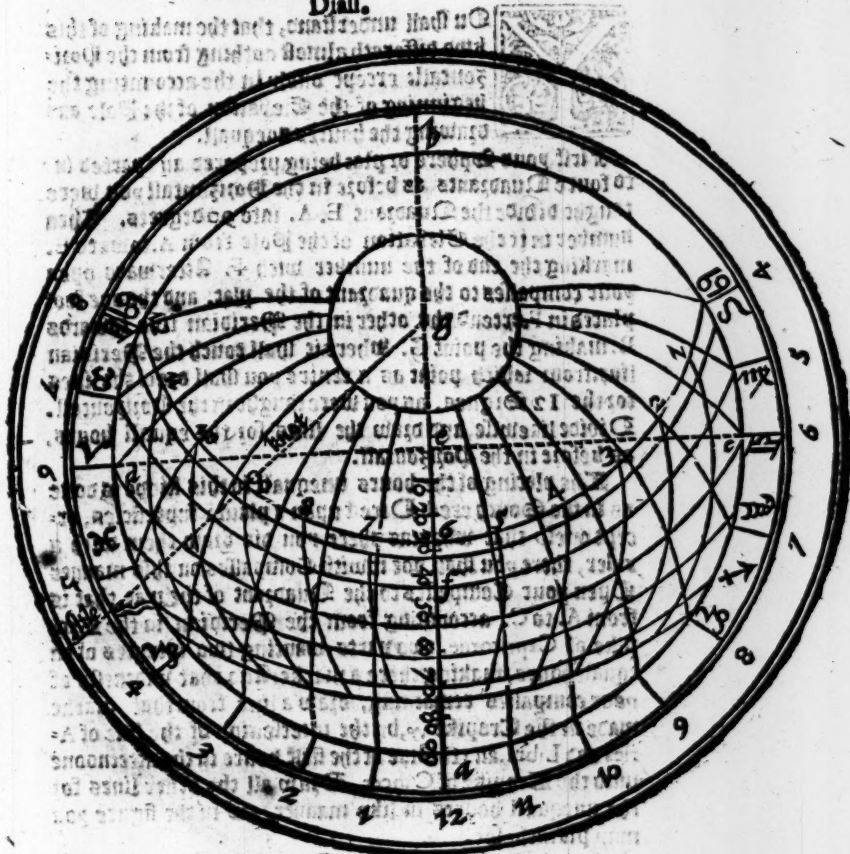
When you will place the houres unequal in this Spher-
icall Dial, divide the Tropike of Cancer and Capricorne
each of them into 12. equal parts, as before you did the Ec-
uator for the equal houres. Then with the Compasses
toyne each three points of these three Arches, and drawe in
to one line wth Arke, untill you have made 12. lines to shew
the 12. unequal houres, as in the Figure following you
may see. Whereof the Perpetuall, or 12. unequal hours
shall alwayes be the 6. unequal houre.

In placing the figures to the equal and unequal houres,
and the Characters to the 12. Signes of the Zodiacke, the
figure may sufficiently shew, notwithstanding you may
place them where you will giving to each signe his proper
Character, and every houre equal and unequal their proper
figures or names.

Fixe the Style in the centre C. standing up so highes the
heighte of the plat, so that the upper end may appeare as
the centre of the circumference, which you may try, by pla-
cing a ruler upon the points A. B. And againe upon C. D.
In like manner you may examine it with your Compasses,
but the former, as practice will teach you, is the more con-
venient way.

You may, if you will, have the Style stand above the plat
so that it may shew the equal houres above the edge of the
Sphere, and then taken a knote of equal height with the
plat, which shall shew the motion of the Sunne in the 12.
signes and the unequal houres which otherwise the end
of the Style should doe, as in the Figure following you may
perceive.

The Figure of an hollow Horizontall Diall.



The

The Art of Dialling

The making of a South Spherical and direct Dial.

Demonstrat. in CHAP. 27. Part I.



Thou shalt understand, that the making of this kind differeth almost nothing from the Horizontal: except onely in the accounting the beginning of the Elevation of the Pole, and drawing the houres unequal.

If first your Spherer or plate being prepared, and parted into four Quadrants, as before in the Horizontal you were taught. Divide the Quadrant E. A. into 90 degrees. Then number in it the Elevation of the Pole from A. toward E. marking the end of the number with F. Afterward open your compasses to the quadrant of the plate, and the one foot place in F extend the other in the Peridian line toward B. making the point G. where it shall touch the Peridian line from which point as a centre you shall draw the lines for the 12 Signes, as you were taught in the Horizontal. Divide likewise, and draw the lines for the equal houres, as before in the Horizontal.

The placing of the houres unequal in this kind is done as in the South erect Direct upon a plaine superficies, except onely that whereas there you did draw them with a ruler, there you shall doe it with Compasses on this manner. Open your Compasses to the Quadrant of the plate, that is from A. to C. according from the Peridian in the Tropike of Capricorne, two parts wanting two minutes of an equal houre, making there a marke: And that widenesse of your compasses remaining, draw a line from that marke made in the Tropike, by the intersection of the line of Aries and Libra, and the line of the first houre in the afternoone unto the Tropike of Cancer. Draw all the other lines for the unequal houres in like manner, as in the figure you may plainly see.

Fixe the stile in the centre G. as you did in the Horizontal, placing the figures for the equal and unequal houres.

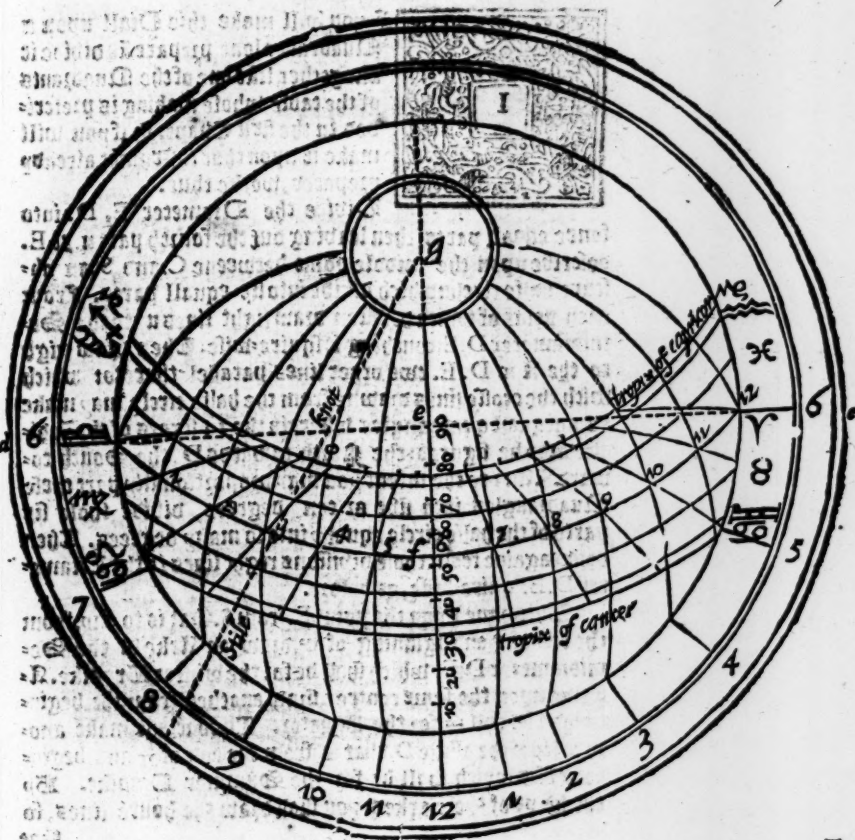
AND

The Art of Dialling.

48

and the Characters to the 12 Signes, as in the example following, or otherwise as you will.

CHAP. 28.

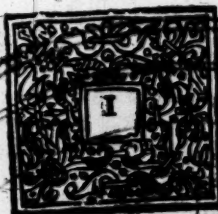


The

The Art of Dialling.

The making of a Diall upon a Quadrant, or the Table described in the Beginning of the Booke.

CHAP. 28.



If you will make this Diall upon a Quadrant alone prepare to divide it altogether like one of the Quadrants of the table whose making is prescribed in the first Chap. or if you will make it upon that instrument already prepared, worke thus.

Divide the Diameter E. D. into foure equall parts; then leaveth out the fourth part u. to E. describe upon the middle points betweene C. and S. an obscure halfe circle: which divide into six equall parts. From each point of which division draw right lines unto the Semidiameter D. E. touching it square-wise. Then draw right to the it is D. E. two other lines parallel thereto for which with the crosse lines drawne from the halfe circle may make 12 unequal quadrangles inbetween the 12 signes of the Zodiacke may be figured: the South towards D. the South towards S. And to the intent you may proportionally part these Quadrangles into five or ten degrees, divide those six parts of the halfe circle equally into so many degrees. Then draw againe from those divisions right lines to the Diameter D. E. square-wise, as before.

Thus done upon the point E. from S. that is to say from the end of π and beginning of ν , draw an Arke to the Semidiameter D. E. which shall be for the winter Tropike. And againe upon the same centre draw another from the beginning of ν and π for the Equator. To conclude, make another from the angle D. that is from the end of π and beginning of ν which shall be for the summer Tropike. By the helpe of these arkes you shall draw the houre lines, so

that you first know the height of the Sunne above the Horizon at every houre, when it occupieth the beginning of γ and δ . Whose altitude is thus found out.

Take the Elevation of the Pole, and the Complement thereof, also the declination of the Sunne from the Equinoctiall, and the distance of the Sunne from the Peridian, accounting 15 degrees for every houre, with the Complement of this distance. Then if you desire to know the altitude of the Sunne at six of the clock either in the morning or at evening (at which houre onely in Summer it is above the Horizon) multiply the Sine of the Elevation of the Pole, by the Sine of the declination of the Sunne, dividing the product by the whole Sine, and you shall have your desire.

But if the Sunne shall be distant from the Peridian fewer houres then six, multiply the Sine of this distance (giving to every houre 15 degrees) by the Sine of the complement of the altitude of the Pole, and the product hereof divide by the whole Sine. Then take the Arke of the quotient from 90 degrees, and the first number found out shall remaine, which must be kept. Then compare the Sine of this number found out with the Sine of the Elevation of the Pole, augment the lesser by the whole Sine dividing the product by the greater: whereof shall come a quotient Sine to the Complement of whose Arke adde the declination of the Sunne, if it shall be in the North signes, or subtract it from that if it occupieth the South signes. And if the number which cometh hereof shall be greater than 90, take it from 180, and you shall have the second number found out. The Sine of this number found out being multiplied, by the Sine of the first number found out, shall yeeld a product, which part by the whole Sine, and the Arke of the quotient Sine, shall shew the desired altitude of the Sunne for the houre propounded.

But if the distance of the Sunne from the Peridian shall exceede six houres (that is 90 degrees) take the de-

The Art of Dialling.

degrees of that distance from 180, multiplying the Sine of $\frac{1}{2}$ remainder by the Sine of the Complement of the altitude of the Pole, dividing the product by the whole Sine, and subtract the Arke of the Quotient from 90, the remainder shall be called, first number found out. The Sine of which number found out compared with the Sine of the Elevation of the Pole increaseth the lesser by the whole Sine, and distributeth the product by the greater. Then take the Complement of the Declination of the Sun, from the Arke of the quotient, and you shall have the second number found out.

Finally, the Sine of the first number found out and the Sine of the second being multiplied by themselves, and the product parts by the whole Sine; the quotient Sine shall yeeld an Arke, which shall be the altitude of the Sunne.

But when the Sunne occupieth the beginning of V or 21 you shall finde the altitude thereof every houre, once by multiplying the Sine of the Complement of the distance of the Sunne from the Peridian by the Sine of the Complement of the Elevation of the Pole, dividing the product by the whole Sine, the quotient which cometh hereby shall yeeld the Arke of your desire. At both the six houres, because the one fixe is selfe rising, and the other the setting, there is then no altitude of the Sunne above the Horizon.

For October, to know how much the Peridian altitude is, of the Sunne entering into S , adde the greatest Declination thereof, to the Complement of the Elevation of the Pole: and by subtracting the greatest Declination of the Sunne from the Complement of the Elevation of $\frac{1}{2}$ Pole, you shall likewise have the Peridian altitude of the Sun entering into V .

You shall likewise seeke the height of the Sunne, being in the 10. degree of δ above the Horizon, at 8 of the clock before noone, and at 4 after noon at 7 in the morning, and 3

The Art of Dialling.

51

in the evening : at both 6 and the 5 houre in the morning and 7 at night. Also at 5 in the morning and 7 in the evening the Sunne being in the beginning of π .

But because the working of this, to find out these altitudes, requireth much time and labour, wee wil set down these distances ready found out, calculated for the Elevation of the Pole 50° . and 52° . which you may likewise use without any notable difference, where the Pole is Elevated 49° . 51° . and 53° .



The first Table calculated for 50° . degrees

Hour.	Hour.	\odot		γ		ψ	$10^{\circ} \delta$	$10^{\circ} \delta$
		D.	M.	D.	M.	D. M.	D. M.	D. M.
	12	63	20	40	0	16 30		
11	1	61	2	38	23	15.19		
10	2	54	42	33	50	11.51		
9	3	46	15	27	26	24		
8	4	36	53	18	45		10 23	
7	5	27	15	9	35		30.55	
6	6	17	47	0	0		11.19	
5	7	8	48				2 37	14
4	8	0	26				0	0

\odot 2

The

The Art of Dialling.

The second Table calculated for 50. degrees of latitude.

Hour.	Hour.	S		V		10 d. S		10 d. V	
		D.	M.	D.	M.	D.	M.	D.	M.
	12	61	30	38	0	14	30		
11	1	59	13	36	28	13	21		
10	2	53	15	34	7	10	0		
9	3	41	13	32	33	4	43		
8	4	30	14	17	32			29	36
7	5	26	53	8	46			19	23
6	6	17	42	0	0			11	4
5	7	8	58					3	47
4	8	1	1					0	0

If therefore you will make your Quadrant Topologically for the elevation of the Pole 50.^{d.} extend a thread, as lay a Ruler, from the centre E. by the 63.^{d.} 30.^{m.} of the limbe of the Quadrant, beginning at F. and where the thread so placed shall touch the Tropike of S, there make a point or mark. Again, let the thread be placed upon the 40.^{d.} of the limbe, and where it shall touch the Equator, there also make a mark. Thirdly, let the thread be drawn by the 16.^{d.} 30.^{m.} of the quadrant: and where it shall touch the Tropike of V, there make likewise a mark. This done, search out the centre (by the 5. Proposition 4. Euclid) and joynethese three markes into one Arke, which shall be the line for the 12. hour. Afterward place the thread upon the 61.^{d.} 30.^{m.} of the limbe, and where it shall cut the Tropike of S, note it. Draw likewise the thread upon the 38.^{d.} 28.^{m.} of the limbe,

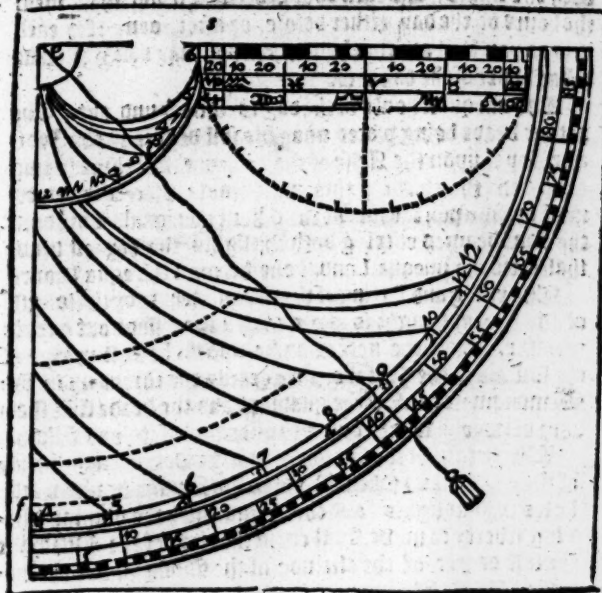
limbe, marke where it cutteth the Equator. Then by the 15. d. 19. m. of the limbe extend the threelines, making a marke in the section thereof and the Tropike of γ . Draw into one Arke these threemarkes (as you did before) finding out the common centre: so shall you have the line of the 11 houre before noon, and 1 afternoone. In like manner are the rest of the houre lines drawn by threepoints, according and found out by the altitude of the Sunne. But because before 9 and after thre, in this Elevation of δ Pole, it will not serve for this delineation, there must another bee made by the Table of the 12 Sines of Quadrangles. Therefore draw that from the 10. d. of δ , so shall you have a line of place wherein the third points may be marked. Then to prepare the points of the Arke for the houre of 8 and 4 of 7 and 1 and both the 6 besides the two markes made in the Tropike of γ and the Equator, let the third be noted in the Arke drawn from the tenth degree of δ . And draw the line of the 9 and 7 houre, use besides the Tropike of Cancer and this drawn from the 10 degree of δ , the circle which shall come from the beginning of π . The line of 4 in the morning and 8 in the evening is very short, included in the angle next unto 1. Thus you have finished 9 Arkes of lines for the houre, of which each one of them doth shew 2 houre: except one which is onely for the 12 houre.

And to the intent that there should be no space left void and unfitable betweene the Tropike of γ and the centre B. you may draw in that place the unequal houre, which you shall very easily doe on this manner. Describe upon the centre E. an Arke b. a little distant from the Tropike of γ . It be divided into 5 equal parts, and take the middle point between the beginning of that Arke at S. and between E. Then upon this point, as it were a centre, make a halfe circle from S. to E. which shall bee the line of the 6 unequal houre, that is of midday. Afterward one foote of the Compasses being placed in the same Semidiameter E.D. and removeth each way as occasion shall require:

The Art of Dialling

and the other extended in the meane time so farre, that it may touch the second point of the Arke divided into 6 parts and the centre E. draw an Arke of line from thence to that point, which shall shew the 5 and 7 houres. In like manner are the other 4 drawn. one foote of the Compasses being removed, as necessity shall require in the Semidiameter E.D (which may be prolonged if it shall be too short) and the Compasses so opened, that the other foote may touch the point of the divided Arke and the centre E. and draw them all in the same Arke line: then draw a thread in the centre E. well waxed, having two small beades upon it to move with a plummet of iron of lead. Last of all prepare two sights of brasse or other metall with points, which you must place in a right line upon the face of edge A. B. so that you may direct them, and againe turn them down upon that side A. B. at your pleasure: that (if you make this dial upon the Table of instrument prescribed in the beginning of this book) they be no hindrance to you in trying or examining of your place. Thus is your Dial prepared: but for further instruction behold the Figure.

The



The use of this Diallor Quadrant.
Horologicall.

TO know the houre of the day when the Sunne shineth, work thus. First, seek out in some Calendar in what Signe and degree the Sunne is at that Day: then extend the thread with the beades upon the Semidiameter E. D. and place the nethermost beade upon that degree, in the Table of the 12 Signes, which the Sunne then occupieth. Afterward lifting up your Quadrant, the thread with the plummet hanging at liberty, let the Sunne beames passe throug
both,

The Art of Dialling

both the sights, and then the nethermost beade shall shew the hours of the day either before, or after noone: for each line as you see, both thus hours, but you may easily discern what hour of the day it is.

The unequal hours of the day is thus found out. The nether beade being placed upon his just degree in the Zodiake, lay it upon the Arke of the 12 houre, the thread being extended: thus holdi^{ng} this immoveable, place the uppermost beade upon the line of the 6 houre unequal: This done the Sunbeames entering both the sights, the highest beade shall shew the unequal, and the nethermost the equal houre.

The rising and setting of the Sunne, whereby the length of the day and night is known, you shall finde out on this manner. Place the nether beade upon the just degree of the Sunne in the Zodiake, then extend the thread upon the Semidiameter E.F. of the quadrant and the beade shall shew at what betwene what houre the Sunne riseth and falleth.

The height of the Sunne above the Horizon at any time of the day is thus taken. Receive the Sunne beames by the holes in your sights, and the thread with the plummet having liberty to move, shall cut in the limb of the Quadrant the just degree of the altitude of the Sunne above the horizon. In the like manner is the elevation of the Stars above the Horizon searched out.

You shall find out the Elevation of the Pole by the h^lpe of your Quadrant, thus. Take the height of the Sunne at 12 of the clock, when the days and nights be of equall length which being substracted from 90.th the Elevation remaineth. But if you assay that upon any other day than the Equinoctiall, you must consider whether the Sunne occupieth the North, or the South signes, as when use the table of the Declination of the Sunne on this wise. When the Sunne is in the North signes, substract his Declination from the Meridian height thereof. But if it be in the South signes, add the declination to his Meridian altitude. The remainder of total Summe being taken from 90.th the Ele-

How

The Art of Dialling.

53

How to make an Instrument, whereby you may know
the just houre of the night by the
Stars.

CHAP. 27.



First prepare a plat of Table of
Plate of firme and solid wood,
which will not change or bend,
of what thicke, let the forme of
it be round, three inches broad, or
more or lesse as you wish. Draw
a circle nigh unto the edge, and
divide it into 12 equal parts:
wherein shall bee placed the 12
Signes of the Zodiake, thus divide each of these parts into
30 equal parts, which shall shew the number of the Dayes
that the Sunne movech in Every Signe. Make a second cir-
cle, wherein you may number the dayes, and a third circle,
wherein write the Characters of the 12 Signes, as you see
in the Figure following.

Draw likewise another circle, wherein you may write
the dayes of every moneth in the year, which you may see
by any Calender, but for more easines sake, behold the Table fol-
lowing, whereby you may perceive how it

is done. A 10. 11. 12. 13. 14. 15. 16. 17. 18. 19. 20. 21. 22. 23. 24. 25. 26. 27. 28. 29. 30. 31. 32. 33. 34. 35. 36. 37. 38. 39. 40. 41. 42. 43. 44. 45. 46. 47. 48. 49. 50. 51. 52. 53. 54. 55. 56. 57. 58. 59. 60. 61. 62. 63. 64. 65. 66. 67. 68. 69. 70. 71. 72. 73. 74. 75. 76. 77. 78. 79. 80. 81. 82. 83. 84. 85. 86. 87. 88. 89. 90. 91. 92. 93. 94. 95. 96. 97. 98. 99. 100. 101. 102. 103. 104. 105. 106. 107. 108. 109. 110. 111. 112. 113. 114. 115. 116. 117. 118. 119. 120. 121. 122. 123. 124. 125. 126. 127. 128. 129. 130. 131. 132. 133. 134. 135. 136. 137. 138. 139. 140. 141. 142. 143. 144. 145. 146. 147. 148. 149. 150. 151. 152. 153. 154. 155. 156. 157. 158. 159. 160. 161. 162. 163. 164. 165. 166. 167. 168. 169. 170. 171. 172. 173. 174. 175. 176. 177. 178. 179. 180. 181. 182. 183. 184. 185. 186. 187. 188. 189. 190. 191. 192. 193. 194. 195. 196. 197. 198. 199. 200. 201. 202. 203. 204. 205. 206. 207. 208. 209. 210. 211. 212. 213. 214. 215. 216. 217. 218. 219. 220. 221. 222. 223. 224. 225. 226. 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1188. 1189. 1190. 1191. 1192. 1193. 1194. 1195. 1196. 1197. 1198. 1199. 1200. 1201. 1202. 1203. 1204. 1205. 1206. 1207. 1208. 1209. 1210. 1211. 1212. 1213. 1214. 1215. 1216. 1217. 1218. 1219. 1220. 1221. 1222. 1223. 1224. 1225. 1226. 1227. 1228. 1229. 1230. 1231. 1232. 1233. 1234. 1235. 1236. 1237. 1238. 1239. 1240. 1241. 1242. 1243. 1244. 1245. 1246. 1247. 1248. 1249. 1250. 1251. 1252. 1253. 1254. 1255. 1256. 1257. 1258. 1259. 1260. 1261. 1262. 1263. 1264. 1265. 1266. 1267. 1268. 1269. 1270. 1271. 1272. 1273. 1274. 1275. 1276. 1277. 1278. 1279. 1280. 1281. 1282. 1283. 1284. 1285. 1286. 1287. 1288. 1289. 1290. 1291. 1292. 1293. 1294. 1295. 1296. 1297. 1298. 1299. 1300. 1301. 1302. 1303. 1304. 1305. 1306. 1307. 1308. 1309. 1310. 1311. 1312. 1313. 1314. 1315. 1316. 1317. 1318. 1319. 1320. 1321. 1322. 1323. 1324. 1325. 1326. 1327. 1328. 1329. 1330. 1331. 1332. 1333. 1334. 1335. 1336. 1337. 1338. 1339. 1340. 1341. 1342. 1343. 1344. 1345. 1346. 1347. 1348. 1349. 1350. 1351. 1352. 1353. 1354. 1355. 1356. 1357. 1358. 1359. 1360. 1361. 1362. 1363. 1364. 1365. 1366. 1367. 1368. 1369. 1370. 1371. 1372. 1373. 1374. 1375. 1376. 1377. 1378. 1379. 1380. 1381. 1382. 1383. 1384. 1385. 1386. 1387. 1388. 1389. 1390. 1391. 1392. 1393. 1394. 1395. 1396. 1397. 1398. 1399. 1400. 1401. 1402. 1403. 1404. 1405. 1406. 1407. 1408. 1409. 1410. 1411. 1412. 1413. 1414. 1415. 1416. 1417. 1418. 1419. 1420. 1421. 1422. 1423. 1424. 1425. 1426. 1427. 1428. 1429. 1430. 1431. 1432. 1433. 1434. 1435. 1436. 1437. 1438. 1439. 1440. 1441. 1442. 1443. 1444. 1445. 1446. 1447. 1448. 1449. 1450. 1451. 1452. 1453. 1454. 1455. 1456. 1457. 1458. 1459. 1460. 1461. 1462. 1463. 1464. 1465. 1466. 1467. 1468. 1469. 1470. 1471. 1472. 1473. 1474. 1475. 1476. 1477. 1478. 1479. 1480. 1481. 1482. 1483. 1484. 1485. 1486. 1487. 1488. 1489. 1490. 1491. 1492. 1493. 1494. 1495. 1496. 1497. 1498. 1499. 1500. 1501. 1502. 1503. 1504. 1505. 1506. 1507. 1508. 1509. 1510. 1511. 1512. 1513. 1514. 1515. 1516. 1517. 1518. 1519. 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1686. 1687. 1688. 1689. 1690. 1691. 1692. 1693. 1694. 1695. 1696. 1697. 1698. 1699. 1700. 1701. 1702. 1703. 1704. 1705. 1706. 1707. 1708. 1709. 1710. 1711. 1712. 1713. 1714. 1715. 1716. 1717. 1718. 1719. 1720. 1721. 1722. 1723. 1724. 1725. 1726. 1727. 1728. 1729. 1730. 1731. 1732. 1733. 1734. 1735. 1736. 1737. 1738. 1739. 1740. 1741. 1742. 1743. 1744. 1745. 1746. 1747. 1748. 1749. 1750. 1751. 1752. 1753. 1754. 1755. 1756. 1757. 1758. 1759. 1760. 1761. 1762. 1763. 1764. 1765. 1766. 1767. 1768. 1769. 1770. 1771. 1772. 1773. 1774. 1775. 1776. 1777. 1778. 1779. 1780. 1781. 1782. 1783. 1784. 1785. 1786. 1787. 1788. 1789. 1790. 1791. 1792. 1793. 1794. 1795. 1796. 1797. 1798. 1799. 1800. 1801. 1802. 1803. 1804. 1805. 1806. 1807. 1808. 1809. 1810. 1811. 1812. 1813. 1814. 1815. 1816. 1817. 1818. 1819. 1820. 1821. 1822. 1823. 1824. 1825. 1826. 1827. 1828. 1829. 1830. 1831. 1832. 1833. 1834. 1835. 1836. 1837. 1838. 1839. 1840. 1841. 1842. 1843. 1844. 1845. 1846. 1847. 1848. 1849. 1850. 1851. 1852. 1853. 1854. 1855. 1856. 1857. 1858. 1859. 1860. 1861. 1862. 1863. 1864. 1865. 1866. 1867. 1868. 1869. 1870. 1871. 1872. 1873. 1874. 1875. 1876. 1877. 1878. 1879. 1880. 1881. 1882. 1883. 1884. 1885. 1886. 1887. 1888. 1889. 1890. 1891. 1892. 1893. 1894. 1895. 1896. 1897. 1898. 1899. 1900. 1901. 1902. 1903. 1904. 1905. 1906. 1907. 1908. 1909. 1910. 1911. 1912. 1913. 1914. 1915. 1916. 1917. 1918. 1919. 1920. 1921. 1922. 1923. 1924. 1925. 1926. 1927. 1928. 1929. 1930. 1931. 1932. 1933. 1934. 1935. 1936. 1937. 1938. 1939. 1940. 1941. 1942. 1943. 1944. 1945. 1946. 1947. 1948. 1949. 1950. 1951. 1952. 1953. 1954. 1955. 1956. 1957. 1958. 1959. 1960. 1961. 1962. 1963. 1964. 1965. 1966. 1967. 1968. 1969. 1970. 1971. 1972. 1973. 1974. 1975. 1976. 1977. 1978. 1979. 1980. 1981. 1982. 1983. 1984. 1985. 1986. 1987. 1988. 1989. 1990. 1991. 1992. 1993. 1994. 1995. 1996. 1997. 1998. 1999. 2000. 2001. 2002. 2003. 2004. 2005. 2006. 2007. 2008. 2009. 2010. 2011. 2012. 2013. 2014. 2015. 2016. 2017. 2018. 2019. 2020. 2021. 2022. 2023. 2024. 2025. 2026. 2027. 2028. 2029. 2030. 2031. 2032. 2033. 2034. 2035. 2036. 2037. 2038. 2039. 2040. 2041. 2042. 2043. 2044. 2045. 2046. 2047. 2048. 2049. 2050. 2051. 2052. 2053. 2054. 2055. 2056. 2057. 2058. 2059. 2060. 2061. 2062. 2063. 2064. 2065. 2066. 2067. 2068. 2069. 2070. 2071. 2072. 2073. 2074. 2075. 2076. 2077. 2078. 2079. 2080. 2081. 2082. 2083. 2084. 2085. 2086. 2087. 2088. 2089. 2090. 2091. 2092. 2093. 2094. 2095. 2096. 2097. 2098. 2099. 2100. 2101. 2102. 2103. 2104. 2105. 2106. 2107. 2108. 2109. 2110. 2111. 2112. 2113. 2114. 2115. 2116. 2117. 2118. 2119. 2120. 2121. 2122. 2123. 2124. 2125. 2126. 2127. 2128. 2129. 2130. 2131. 2132. 2133. 2134. 2135. 2136. 2137. 2138. 2139. 2140. 2141. 2142. 2143. 2144. 2145. 2146. 2147. 2148. 2149. 2150. 2151. 2152. 2153. 2154. 21

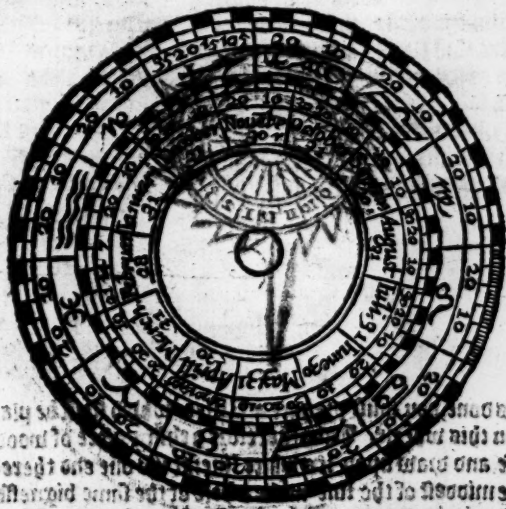
The Art of Dialling.

Moneth	Dayes	Deg.	M. Kata. & of the 12 Signes.	Signes.
January	1	20	13	Capricorne
	15	5	33	Aquarius
	31	11	44	Pisces
February	24	19	48	Aries
	18	19	50	Taurus
March	17	19	52	Gemini
	11	19	54	Cancer
April	10	19	56	Leo
	1	19	58	Virgo
May	1	19	60	Libra
	1	19	62	Scorpius
June	1	19	64	Sagittarius
	1	19	66	Capricorne
July	1	19	68	Aquarius
	1	19	70	Pisces
August	1	19	72	Aries
	1	19	74	Taurus
September	1	19	76	Gemini
	1	19	78	Cancer
October	1	19	80	Leo
	1	19	82	Virgo
November	1	19	84	Libra
	1	19	86	Scorpius
December	1	19	88	Sagittarius
	1	19	90	Capricorne

Enter this Table and you shall find that the first day of January must be placed against the 20. 13. of Capricorne, and the 15. day against the 5. 33. of Aquarius &c.

Wherefore lay your ruler upon the centre A. of your plate and upon the 20. 13. of \cap , and where it shall touch the circle make a mark for the dayes of every month. there make a marke which shall shew the first day of January. Then lay it upon the 5. 33. of ♊ and the centre A. and where it shall touch the circle, make a marke for the 15. day of January. Then lay your ruler upon A. and the 31. 44. of ♋ , and make likewise a marke for the 31. day of January. Again place the ruler upon the centre A. and the

5^d 52^m of X, for the 14 day of February: worke thus with all the rest, until you haue set downe the beginning and middell of every moneth as the table doth shew: you the having found out the beginning and middell of every moneth you may at ease divide every space into so many parts as there be dayes in the moneth, which is easy to be done, according as you see in this figure following. It shall be also necessary to make one circle so, with the number of the dayes of the moneth, and another for the names of the moneths: you must make also a hole in the centre of this plan of such bignesse, as you may see a Dialle thereon: as in the figure you may perceive.



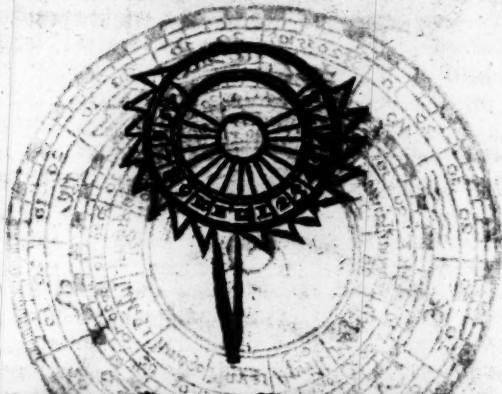
Having prepared this plan with the circles upon it, for the 12. Signes and moneths you must prepare another wheele full of text, which you shall make in this manner.

Take a round Table or plate of the same matter your
 12 13 2 other

The Art of Dialling.

other was, draw a circle upon it so great as the inward circle of the first plat, and divide it into 12 equal parts. Then draw lines from the centre to every one of those parts, until you have so many as there be houres in the longest night in your Countrey. When cut teeth by these lines for the houres; and write the number of them upon the teeth as you see in this figure. Let the tooth for the 12 houre be so long from the centre to the end, as it is betweene the centre A. of the other plat, and the circle of the 12. Dignest you must likewise make a hole in the centre of this wheele, of the same dignesse of that in the other plat.

The Toched Wheele.

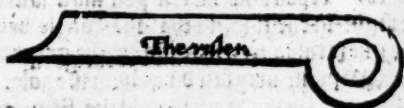


This done, you must prepare a Ruler, which shall be placed upon this wheele. Take therefore a square piece of wood or brass, and draw upon it a white line, at the one end thereof in the midst of the line make a hole of the same dignesse which that is in the great plat and Toched wheele. Then draw a circle that is in inch three or more if you will, afterwards cut the Ruler round at the end, cutting off likewise the six balls at the bottom of the Ruler by the line.

Act

The Art of Dialling. 55

Let the length of the Ruler from the centre to the end be of such quantity, as is from the centre of the great plat to the outward edge, and an inch or more if you will.



The length of your Instrument being finished: the backside must have two small holes, and a handle, which may turne and move about. Prepare them thus.

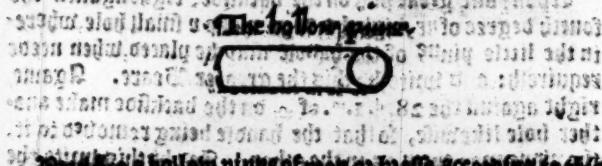
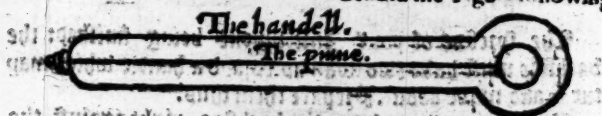
Upon your great plat on the backside, right against the fourth degree of α , right the edge make a small hole, where in the little pinne of the handle may be placed, when neede requireth: and write by this the greater Beare. Again, right against the 28. γ . of α on the backside make another hole likewise, so that the handle being removed to it, the pinne may enter as in the other. And by this write the little Beare, &c.



The Art of Dialling.

Prepare for your handle a thimble plate of iron, brass, or wood, about 6 inches in length or more if you will. Draw in the midst of it a line: at the one end thereof make a hole in the midst of the line of such bignesse as the hole in the greater plate is. Upon this handle you must fasten a little short pinne right in the line, so that the handle being fastened with the pinne to the backside of the greater plate, and being moved, the pinne may fall directly in the hole.

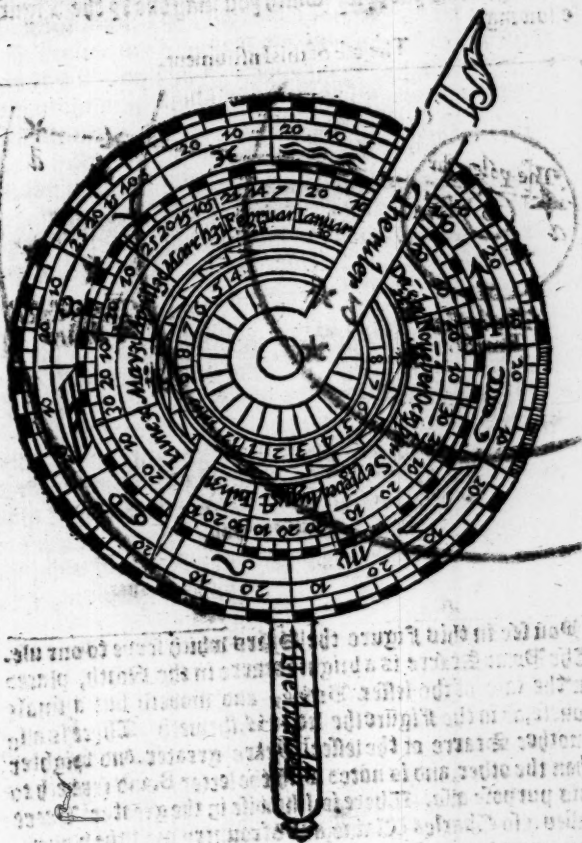
Behold the Figure following



Prepare a hollow pinne of iron or brass according to this Figure above, so great as it may easily enter into the hole of the handle, so that it may move upon it: but let it go close into the greater plate, that it may remaine immovable. Let the Lothed wheeles and the Ruler make the hole upon it. When place the Lothed wheeles and the Ruler on the former side of the plate upon the pinne, and on the backside of the handle with the little pinne towards the back of the plate: fasten them so together, that the handle, the Lothed wheeles, and the Ruler may turne upon the plate severally, or each by themselves at your pleasure, and as he shall require. Notwithstanding you must be careful, that the hole in your pinne may bee so great as you may perfectly see the North Starre in the night throughout. When your Instrument shall be finished, whose use so I have effected.

For the better understanding behold the Figure.

310

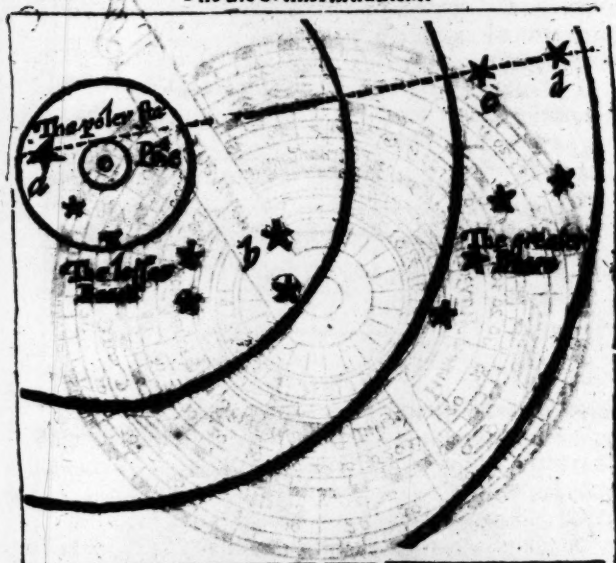


This is a portable sundial, which may be used in any
 place, and at any time, to find the hour of the day.
 The dial is divided into four quadrants, and the
 hours of the day are marked on the outer ring.
 The minutes of the day are marked on the inner
 ring. The gnomon is the shadow-casting needle.
 The dial is mounted on a small base.
 The dial is used by placing it on a flat surface,
 and adjusting it so that the gnomon is parallel
 to the Earth's axis. The shadow of the gnomon
 will then fall on the dial, and the hour of the
 day can be read off.

The Art of Dialling.

First it shall be expedient to find out the Starres serving to this purpose, which you may doe by the Figure following.

The use of this Instrument.



You see in this Figure the Starres which serve to our use. The Polar Starre is a bright Starre in the North, placed in the tale of the lesser Beare, and moveth but a small course, as in the Figure the letter A. sheweth. There is also another Starre of the lesser Beare greater and brighter than the other, and is noted with the letter B. and serveth to this purpose also. There is likewise in the greater Beare called also Charles Waine, and of country men the plough, two great bright Starres, and are placed almost in a right line with the Polar Starre, and are noted with the letters C, D. And these two Starres have 3 other bright Starres

by

by them, but not to go out as the other doe. **W**here Starres which you see in the Figure, as all other, move equally above the Po'e, and finish their course in 24 houres.

Therefoze when you want to know the houre of the night by this Instrument, doe thus place the right line of ϕ long tooth of the 22 hour directly over the day of the month, and turne the handle on the backside to the hole of the greater Beare, and your Instrument shall be prepared.

Then lift up your Instrument by the handle perpendicularly, so that it declineth on neither sides: and beholding the Polare Starre throu the hole in the centre, move ϕ Ruler above, untill the right line thereof be directly against ϕ seemeth to touch the two Starres of the greater Beare, & under the line you shall have the iust houre of the night: which you may finde out by the number of the teeth with your Figure in the night. But if you cannot see the two Starres of the greater Beare, because of Clouds: and yet you may see the Polare Starre, and the Starre of ϕ lesser Beare, move with the letter B. remove the handle on the backside to the hole of the lesser Beare. Then lift up your Instrument as before, and behold the Polare Starre at the hole, and turne the Ruler to the hole said Starre of the lesser Beare, and you shall finde the true houre of the night, as before is taught.

The making of a Diall, to know the houre by the Moode

CHAP. 30.



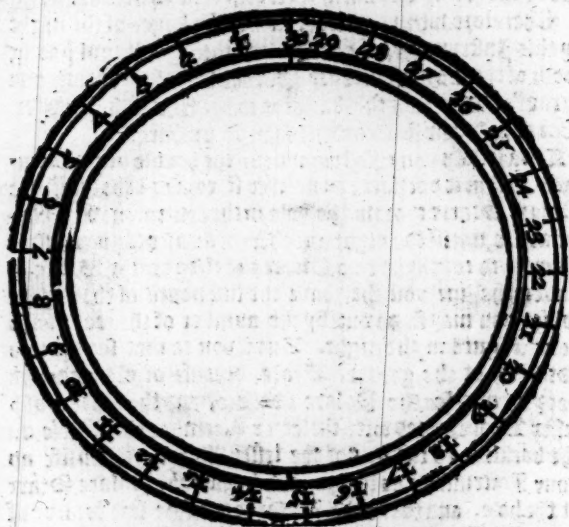
Prepare a square piece of wood or metal 3 or 4 inches over, draw thereon a circle so great as you can draw also another within that. Now because the Moon finisheth her course in 29 days 12 houres, and 44 minutes, part the number into 30 parts in this manner
 $29 \times 60 = 1740$ which is the last must not be so great by a third part: wherefoze divide one of these 29

Q

equall

The Art of Dialling:

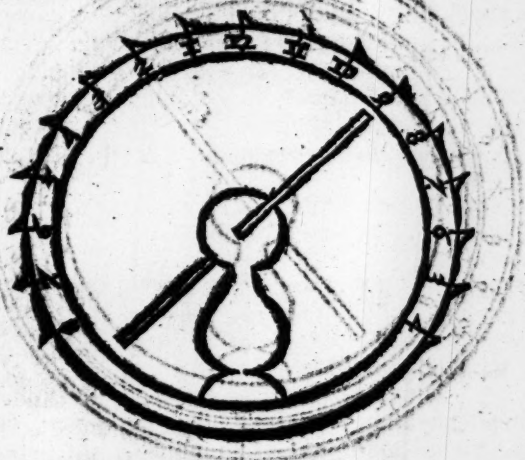
equall parts into thre parts, and take two of them for the 30. and last part.



Cut out that which is within the inward limbe, and prepare another of the same, or like wood or metall somewhat thicker, and worke it so that it may goe into the former, so much of the thickness as it may be equall on the back side and that which remaineth of the thickness, let it hang over the foreside of the first plat, so keepe it from falling thowol: draw a circle upon it, and divide it into 24 equall parts. draw from these parts houre lines so many as shall suffice for the longest night: cut that which overhangerth with teeth at every houre, but especially at the 12 houre make a long tooth, fixe a wper in the centre for the stile equally distant from the circle on each side. Let the stile hang so much

The Art of Dialling. 58

much beneath þ plat, as it is aboue, because you shall haue
as much us on the backside as before.

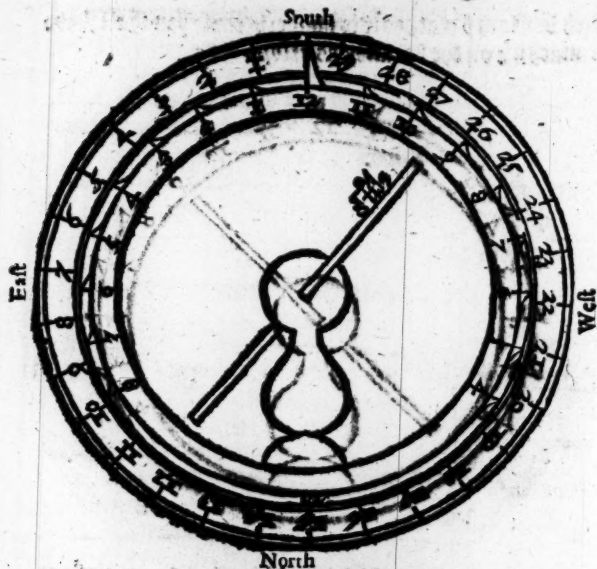


Cut out all that which is within the inward circle ex-
cept a little portion to support the stile, so that this shall
be but a hoop. Draw the houre lines on the backside of
this plat, as on the foreside, so that one may be right a-
gainst another: then draw lines on the inside, from every
one of these lines on the foreside, to the lines of the back-
side. This plat or wheele must bee moveable, and turne
within the former.

D 2

South

The Art of Dialling.



North
The use of this Diall.

Place this Diall that each side may behold one quarter of the world, so that the South be the South the North be the North, &c. Wherever, it must rectine according to the elevation of the Equinoctiall so that the Poone being in the Equinoctiall circle, shall give light both above and beneath this Diall. You may place it perfectly with your Instrument.

Your Diall being thus placed, when you would know the houre of the night, first learne the age of the Poone by an almanack and especially the houre of the change, then turne the great over-hanging tooth, to the day of the Poone on the Diall, and the houre of the change, accounting from 12 of the clock.

The

The shadow of the stile shall show the hour of the night either beneath your Dial or else above.

This Dial will serue also for the Sunne, if you turne the great tooth of the moveable wheale to the little stick A. which is right opposite to the beginning of the first and last of the last day of the Moore neere the 15. day, and then it is fit for the Sunne. For it differeth nothing from a Dial reclining direct, where the Reclination is equall to the Elevation of the Pole.

The use of the Table of the declination of the Sunne



Take what degree you will of any signe, & by this table you may know his declination from the Equinoctial circle. The Signes are written partly on the head of the Table, and partly on the foot of the same.

The degrees in the first colunne doe serue for the Signes that be on the head of the Table, and the Degrees in the last colunne doe serue for the Signes in the foot of the Table. And the common Arc or angle against the Signes and the degree which you seek for, both containe the degrees and minutes of the Declination due to the same.

Example

I would know how much the tenth degree of Leo doth decline from the Equinoctiall: I must looke in the colunne over Leo, right against the number of 10. in the last colunne where I finde 17. 45. the declination thereof.

The Art of Dialling

The Table of the declination of the Sunne,
from the Equinoctial circle.

Aries.		Taurus.		Gemini.	
Libra.		Scorpius.		Sagittarius.	
Deg.	Deg.	M	Deg.	M	Deg.
1	0	34	11	30	20
2	0	48	12	11	28
3	1	12	12	22	20
4	1	36	12	32	20
5	1	59	13	12	21
6	2	23	13	36	21
7	2	47	13	52	21
8	3	11	14	12	21
9	3	34	14	31	21
10	3	58	14	50	21
11	4	20	15	19	22
12	4	45	15	27	22
13	5	8	15	55	22
14	5	32	16	2	22
15	5	55	16	21	22
16	6	18	16	39	22
17	6	41	16	56	22
18	7	4	17	13	22
19	7	27	17	29	23
20	7	50	17	46	23
21	8	12	18	2	23
22	8	35	18	17	23
23	8	57	18	33	23
24	9	10	18	48	23
25	9	32	19	2	23
26	10	54	19	17	23
27	10	15	19	31	23
28	10	47	19	40	23
29	11	8	19	50	23
30	11	29	20	12	23
Deg.	Deg.	M	Deg.	M	Deg.
Virgo.		Leo.		Cancer.	
Pisces.		Aquarius.		Capricorn.	

The Table of Sines.

The whole Sine consisteth 100000 parts

The use of the table of Sines.

Whereas the making of some *Dialls*, and this Table of Sines may seeme obscure and hard to them who are not acquainted with *Sinistrall* computation, it shall be expedient to declare the use hereof, so much as pertaineth to the understanding of this booke, omitting all other uses as impertinent to our present purpose. Wherefore know that the *Grades* or *Degrees* are found in the upper head of this Table, and the *Minutes* pertaining to the degrees on the left side, & in the Area or common meeting of the both, a number which is called the *Sine*, answerable to each Degree and Minute: offereth it selfe. Again, the *Sine* being found out, you may easily know the *Arche*, that is the Degrees and Minutes thereof, these being on the left hand, the other on the head or upper part. Understand by the Complement that which remaineth of any number being taken or subtracted from 90 Degrees. If at any time you enter the Table with full Degrees without any minutes, resolve one Degree into 60 minutes, and then seeke out his *Sine*. And whereas you shall finde some numbers imperfect, you must remember to supply their want with those which be perfect immediately going before.

Example.

The Elevation of the Pole at Cambr. is 52. Degrees, whose Sine I desire to know, therefore resolving one of the Degrees into Minutes, I enter the Table with 51 Degrees,

The Art of Dialling.

gross, 60. Minutes, and the common Area I find the Signe to be 78301. If then you desire to know the complement of this elevation, subtract 52. out of 90. and the remainder shall be 38. the complement thereof and entering e the Table with 37^d. 60^m. you shall finde in the Area 66. which number because it is imperfect, you must supply the want thereof by adding 3. former figures in that which is next before perfect, to wit. 615. and then the whole number shall be 61566 the Signe of 38.^d. Which is the Complement of 52.^d. the Elevation of the Pole.

These things well considered, there is nothing in this book so obscure, but it shall seeme plain and easie.

Masters under Teaching.

F I N I S.

1	1	1	1	1	1	1
2	2	2	2	2	2	2
3	3	3	3	3	3	3
4	4	4	4	4	4	4
5	5	5	5	5	5	5
6	6	6	6	6	6	6
7	7	7	7	7	7	7
8	8	8	8	8	8	8
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44	44	44	44	44	44	44
45	45	45	45	45	45	45
46	46	46	46	46	46	46
47	47	47	47	47	47	47
48	48	48	48	48	48	48
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50	50	50	50	50	50	50
51	51	51	51	51	51	51
52	52	52	52	52	52	52
53	53	53	53	53	53	53
54	54	54	54	54	54	54
55	55	55	55	55	55	55
56	56	56	56	56	56	56
57	57	57	57	57	57	57
58	58	58	58	58	58	58
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60	60	60	60	60	60	60
61	61	61	61	61	61	61
62	62	62	62	62	62	62
63	63	63	63	63	63	63
64	64	64	64	64	64	64
65	65	65	65	65	65	65
66	66	66	66	66	66	66
67	67	67	67	67	67	67
68	68	68	68	68	68	68
69	69	69	69	69	69	69
70	70	70	70	70	70	70
71	71	71	71	71	71	71
72	72	72	72	72	72	72
73	73	73	73	73	73	73
74	74	74	74	74	74	74
75	75	75	75	75	75	75
76	76	76	76	76	76	76
77	77	77	77	77	77	77
78	78	78	78	78	78	78
79	79	79	79	79	79	79
80	80	80	80	80	80	80
81	81	81	81	81	81	81
82	82	82	82	82	82	82
83	83	83	83	83	83	83
84	84	84	84	84	84	84
85	85	85	85	85	85	85
86	86	86	86	86	86	86
87	87	87	87	87	87	87
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90	90	90	90	90	90	90
91	91	91	91	91	91	91
92	92	92	92	92	92	92
93	93	93	93	93	93	93
94	94	94	94	94	94	94
95	95	95	95	95	95	95
96	96	96	96	96	96	96
97	97	97	97	97	97	97
98	98	98	98	98	98	98
99	99	99	99	99	99	99
100	100	100	100	100	100	100

D	0	1	2	3	4	5
M	Parts	Parts	Parts	Parts	Parts	Parts
1	29	1774	3519	5362	7004	8744
2	58	1803	48	91	33	73
3	87	32	77	5320	62	8803
4	116	61	3606	49	19	131
5	45	90	35	78	7120	60
6	74	1919	64	5407	49	89
7	203	48	93	36	78	8918
8	32	77	3722	65	7107	47
9	61	2007	51	95	36	76
10	90	36	80	5524	65	9005
11	319	65	3809	53	94	34
12	49	94	38	82	7323	63
13	78	2123	67	5611	52	92
14	407	52	96	40	81	9121
15	36	81	3925	69	7410	50
16	65	2210	55	98	39	79
17	94	39	84	5727	68	9208
18	523	68	4013	56	97	37
19	52	97	42	85	7526	66
20	81	2326	71	5814	55	94
21	610	55	4100	43	84	9325
22	39	85	29	72	7613	52
23	69	2414	58	5901	42	81
24	98	43	87	30	71	9410
25	727	72	4216	59	17700	39
26	56	2501	45	88	29	68
27	85	30	74	6017	58	97
28	814	59	4303	46	87	9526
29	43	88	32	75	7816	55
30	73	2617	61	6104	45	84

D	0	1	2	3	4	5
M	Parts.	Parts.	Parts.	Parts.	Parts.	Parts.
31	901	2646	4391	6133	7874	9615
32	30	79	4420	62	7903	42
33	59	2704	49	91	32	73
34	89	34	78	6220	61	9700
45	1015	63	4509	50	90	29
36	47	92	36	99	8019	58
37	76	2822	65	6308	48	87
38	1105	50	93	37	77	9816
39	34	79	4622	66	8106	45
40	63	2908	52	95	35	74
41	92	87	81	6424	64	9903
42	1212	66	4710	53	93	31
43	50	95	39	82	8222	60
44	79	3034	68	6511	51	89
45	1208	53	87	40	80	10018
46	38	82	4816	69	8309	47
47	67	3119	55	98	38	76
48	96	41	84	6627	67	10105
49	1425	70	4914	56	96	34
50	54	99	43	84	8425	65
51	83	3228	72	6714	54	92
52	1512	57	5001	43	83	10221
53	41	80	30	72	8512	50
54	70	3315	59	6801	51	79
55	99	44	88	39	70	10308
56	1628	73	5117	59	99	37
57	57	3402	46	88	8628	69
58	87	31	75	6917	57	94
59	1716	60	5204	46	86	10423
60	45	89	33	75	8712	52

D	6	7	8	9	10	11
M	Parts.	Parts.	Parts.	Parts.	Parts.	Parts.
1	10481	12215	13946	15672	17393	19109
2	10510	44	74	15700	17422	38
3	39	73	14003	29	50	60
4	68	12302	32	57	97	95
5	97	31	63	83	17508	19223
6	10626	60	90	15801	36	52
7	55	89	14118	44	65	80
8	84	12417	47	73	93	13909
9	10713	46	76	15901	17622	37
10	42	75	14205	30	53	66
11	71	12504	34	59	79	94
12	99	33	62	88	17708	19423
13	10828	62	91	16016	37	51
14	57	91	14320	45	65	80
15	80	12619	94	74	94	19500
16	10915	48	78	16103	17822	37
17	44	77	14406	31	53	66
18	73	12706	35	60	80	94
19	11002	35	64	89	17908	19623
20	31	64	93	16217	37	51
21	60	93	14521	46	66	80
22	89	12821	50	75	94	19708
23	11116	50	79	16303	18023	37
24	46	79	14608	32	51	65
25	75	12908	37	61	80	95
26	11204	37	65	89	18109	19823
27	33	66	94	16418	37	51
28	62	94	14723	47	66	79
29	91	13023	52	76	94	19908
30	11320	52	80	16504	18223	36

Day	6	7	8	9	10	11
M	Part.	Part.	Part.	Part.	Part.	Part.
31	349	13081	14802	16545	18255	19965
32	78	13110	38	62	80	93
33	1407	39	67	96	18303	20021
34	35	67	96	16619	37	50
35	64	96	14924	48	66	79
36	53	13225	53	76	92	20107
37	11522	34	83	16703	18423	36
38	51	83	15011	34	52	64
39	80	13312	39	61	80	93
40	1609	40	68	91	18505	20211
41	38	69	97	16820	38	50
42	67	98	15126	48	66	78
43	95	13427	54	77	93	20307
44	11724	56	83	16906	18623	35
45	53	85	13212	34	52	64
46	82	13513	41	63	80	92
47	11811	42	69	91	18709	20411
48	40	71	98	17020	38	49
49	69	13600	13327	49	66	78
50	98	82	50	78	95	20506
51	11937	58	84	17106	18813	35
52	35	86	15413	35	52	63
53	84	13725	42	64	80	93
54	12013	44	71	92	18909	20910
55	42	73	99	17213	38	48
56	72	13802	15528	50	65	77
57	12100	30	57	78	99	20705
58	29	59	89	17307	19023	34
59	58	88	15614	36	52	62
60	86	14912	43	44	80	91

D	I 12	II 13	III 14	IV 15	V 16	VI 17
M.	Part.	Part.	Part.	Part.	Part.	Part.
1	20819	22523	24218	25910	27591	29264
2	48	13	48	38	27619	92
3	76	89	76	66	47	29320
4	20904	22608	24305	94	75	48
5	33	36	33	26012	27703	76
6	61	63	61	50	31	29404
7	90	98	89	78	59	31
8	21018	22721	24417	26105	87	59
9	47	50	46	34	27819	87
10	75	78	74	62	43	29515
11	21104	22806	24501	90	71	43
12	32	35	30	26218	66	70
13	60	63	52	46	27927	98
14	89	91	87	75	54	29626
15	21217	22920	24615	26303	82	14
16	48	48	43	31	28010	81
17	74	76	71	59	38	29709
18	21303	23004	24701	87	66	37
19	31	33	24718	26415	94	65
20	59	61	56	43	28122	93
21	88	90	84	71	50	29820
22	21415	23118	24812	99	78	48
23	43	40	40	26527	28205	76
24	72	74	69	55	34	29904
25	21501	23203	24907	83	62	31
26	30	31	24924	26611	89	59
27	58	59	53	39	28317	87
28	87	87	81	67	47	30015
29	21615	23316	25009	95	73	43
30	43	44	38	26723	28401	70

D	I2	I3	I4	I5	I6	I7
M	Part	Part	Part	Part	Part	Part
1	21072	23372	25060	26751	28429	30098
2	21700	24002	94	79	57	30126
3	29	89	25122	26807	88	83
4	57	57	50	39	28513	81
5	85	81	78	63	40	30209
6	21814	23514	25208	91	68	36
7	42	42	38	26910	96	64
8	71	70	65	48	28624	92
9	99	99	94	70	52	30320
10	21927	23627	25319	27004	81	47
11	156	58	47	32	28708	75
12	84	83	75	86	36	30402
13	22015	23715	25403	88	63	31
14	41	41	33	27116	91	58
15	69	68	68	44	28819	86
16	98	96	88	72	47	30514
17	22110	23810	25506	27200	75	41
18	54	53	44	28	28903	69
19	83	81	72	50	31	97
20	22211	23909	25600	84	58	30654
21	30	28	28	173	86	52
22	68	66	57	84	30	80
23	99	94	89	67	42	30707
24	22325	24023	25713	95	70	35
25	53	51	42	27423	98	63
26	81	79	69	51	29123	91
27	22410	24107	97	70	53	30818
28	38	35	25825	27507	81	46
29	66	63	58	35	29209	74
30	95	92	83	63	37	30901

D	18	19	20	21	22	23
M	Parts.	Parts.	Parts.	Parts.	Parts.	Parts.
81	00929	32584	34229	35863	37487	39909
82	00	57 32601	56	90	47514	39126
83		84 39805	84 33918		41	53
84	31012	88 66	34311	45	68	80
85	002	39 94	38	72	95	39206
86		67 32711	65	99	37622	33
87		95	49 202	93 36024	49	60
88	31122	88 76	34420	53	76	87
89	002	50 31804	47	81	37703	39313
90		78	31 072	75 36108	82	40
91	31209	88 59	34502	31	57	67
92	002	33 86	29	62	84	94
93		61 32914	52 172	82 37811		39420
94		88 41	84 36216	37	47	
95	31316	88 69	34611	43	64	74
96	002	44 90	89 70	21	39501	
97		71 33023	66 722	98 37918		27
98		69 82	93 36325	45	54	
99	31426		78 34720	52	73	81
100	002	54 33106	48 722	70 38026	99	39602
101		82 33	51 73	36406	38026	34
102	31509	002	61 34806	38	53	61
103	002	57 88	39	60	80	88
104		64 33216	57 722	87 38107		39714
105		91 43	84 36514	33	41	
106	31620	100	70 34920	43	60	68
107	002	47 98	38	60 38107	87	94
108		75 33325	72 66	87 38214		39821
109	31702	002	53 93	36623	41	48
110	002	80 35020	50	68	74	

D	18	19	20	21	22	23
M	Paris.	Paris.	Paris.	Paris.	Paris.	Paris.
31	31758	33408	35047	36677	38295	39901
32	85	33	79	36704	38322	28
33	31831	62	35102	34	48	54
34	40	90	29	58	75	81
35	68	33517	50	89	38401	40008
36	95	45	84	36822	39	34
37	31923	72	35210	39	56	67
38	51	99	38	60	83	88
39	78	33622	65	93	38500	40114
40	32006	54	59	36920	36	41
41	33	82	35120	47	43	68
42	61	33700	47	74	90	94
43	88	36	74	37001	38617	40221
44	32116	62	35401	28	44	48
45	43	91	26	55	71	74
46	71	33819	56	82	99	49301
47	99	46	83	37109	38724	20
48	32226	73	35510	36	50	54
49	34	33901	37	63	78	81
50	81	28	75	90	38805	40409
51	32300	55	92	37217	33	34
52	36	83	35619	44	58	60
53	64	34010	46	71	85	87
54	91	37	73	98	38912	40512
55	32419	65	35700	37325	49	49
56	46	92	28	46	65	67
57	74	34119	55	70	92	93
58	32501	47	82	37406	39019	40620
59	22	74	35809	53	46	47
60	56	34202	30	60	73	75

D	24	25	26	27	28	29
M	Paris.	Paris.	Paris.	Paris.	Paris.	Paris.
1	40707	42288	43863	45424	46972	48506
2	26	42314	89	10	98	21
3	53	49	43913	76	47044	57
4	79	67	41	45502	49	82
5	40806	93	67	28	75	48608
6	83	42419	92	54	47101	33
7	39	46	44919	80	26	58
8	86	73	45006	86	52	84
9	40932	98	72	32	78	48709
10	39	42531	98	58	47203	35
11	65	51	4484	83	29	60
12	92	77	52	45709	55	85
13	41018	42640	76	36	80	48811
14	45	30	44292	61	47306	36
15	74	56	28	87	31	62
16	98	83	54	45833	57	87
17	41044	42709	81	39	83	48912
18	51	35	44207	64	47408	38
19	77	62	33	90	34	63
20	41204	88	59	45916	60	88
21	80	42814	85	42	85	49014
22	37	40	44411	68	47511	39
23	83	67	37	94	36	65
24	41310	93	63	46019	62	90
25	36	42919	89	45	88	49115
26	68	46	44515	71	47613	41
27	80	73	41	97	39	66
28	41416	98	67	46123	64	91
29	42	43024	94	49	90	49217
30	69	51	44619	74	47713	42

D	24	25	26	27	28	29
M.	Parti.	Parti.	Parti.	Parti.	Parti.	Parti.
31	41495	43077	44643	46100	47745	49267
32	41512	43103	44674	46122	47767	49291
33	48	29	97	31	97	49318
34	75	56	44723	78	47818	49
35	41601	82	49	46303	44	68
36	18	43308	75	39	69	94
37	54	34	44801	55	49	49419
38	80	61	27	81	47910	44
39	41707	87	53	4400	45	70
40	33	43313	79	32	72	95
41	60	32	44905	58	96	49520
42	86	65	36	84	48022	45
43	41813	92	57	46509	42	71
44	39	43418	81	35	73	96
45	65	44	45009	61	98	49621
46	52	70	39	87	48124	46
47	41918	96	61	46612	49	72
48	45	43524	87	38	75	97
49	71	49	45113	64	48100	49822
50	98	75	39	90	26	47
51	41024	43601	65	46715	51	73
52	50	27	91	41	77	98
53	77	54	45117	67	48302	49823
54	42103	80	43	92	28	48
55	29	43708	69	46818	53	73
56	56	32	95	44	79	99
57	83	38	45321	70	48404	49924
58	42209	84	47	95	30	49
59	35	43810	73	46911	55	74
60	61	37	99	47	80	50000

D	30	31	32	33	34	35
M	Parti.	Parti.	Parti.	Parti.	Parti.	Parti.
1	50025	51528	53016	54488	55943	57381
2	50	51	41	54512	56	57405
3	75	78	65	37	91	29
4	50100	51603	90	51	56015	52
5	25	28	33115	85	39	76
6	51	53	39	54630	53	57500
7	26	78	64	34	87	24
8	50201	51703	89	58	56112	48
9	26	28	33218	82	36	71
10	51	52	38	54707	60	85
11	76	77	63	31	84	57619
12	50300	51802	87	56	56208	43
13	27	27	33312	80	31	67
14	52	52	36	54804	66	98
15	70	79	68	39	89	57714
16	50402	51908	86	53	56304	38
17	27	27	53410	77	28	62
18	51	51	33	54908	52	85
19	77	76	39	26	76	57809
20	50502	52002	84	50	56400	33
21	28	26	33508	76	24	56
22	53	51	33	99	48	80
23	78	78	58	55023	72	57904
24	50603	52100	82	48	96	28
25	28	25	33607	78	56520	51
26	53	50	34	96	44	75
27	78	75	56	55120	68	99
28	50703	52200	80	41	92	58022
29	28	35	33705	69	56616	46
30	51	49	22	23	49	70

D	30	31	32	33	34	35
M.	Parti.	Parti.	Parti.	Parti.	Parti.	Parti.
31	50778	52274	53754	55217	56664	58093
32	50803	99	79	41	88	58117
33	29	52324	53804	68	56713	41
34	54	49	28	90	36	64
35	79	75	52	55314	60	88
36	50904	98	79	89	84	58212
37	29	52433	53901	63	56808	33
38	54	46	26	87	32	59
39	79	72	50	55412	56	83
40	51004	97	75	36	80	58306
41	29	52522	99	60	56904	30
42	54	47	54024	84	27	54
43	79	71	48	55508	51	77
44	51104	98	72	32	75	58401
45	86	52611	97	57	99	24
46	54	46	54121	81	57023	48
47	79	70	46	55605	47	72
48	51204	95	70	29	71	95
49	29	52700	95	53	93	58519
50	54	45	54119	77	55119	42
51	79	69	44	55702	42	66
52	51304	94	68	26	66	90
53	29	52819	99	50	90	58613
54	54	43	54317	74	57214	37
55	79	68	41	98	38	60
56	51404	93	66	55822	62	84
57	28	52917	90	46	86	58707
58	53	41	54415	71	57309	31
59	68	77	39	95	33	54
60	51503	91	63	55919	57	78

D	36	37	38	39	40	41
M	Parts.	Parts.	Parts.	Parts.	Parts.	Parts.
1	58802	60204	61589	62554	64301	65627
2	25	27	61611	77	23	49
3	49	51	34	99	45	71
4	72	74	57	63022	67	93
5	96	97	80	45	90	65715
6	58919	60320	61703	67	64412	35
7	43	44	26	90	34	59
8	66	67	49	63112	56	81
9	90	90	72	35	79	65803
10	59013	60413	95	57	64508	25
11	37	36	61817	80	23	47
12	60	59	40	63202	45	68
13	84	38	63	25	67	90
14	59107	60506	86	48	90	195912
15	30	29	61902	70	64612	34
16	54	52	32	92	34	56
17	77	75	55	63315	56	78
18	59201	98	77	38	78	66000
19	42	60621	62000	60	64701	22
20	48	45	23	83	23	43
21	71	68	46	63405	45	65
22	95	91	69	28	67	87
23	59318	60714	91	50	89	66109
24	41	37	62114	73	64811	31
25	65	60	37	95	34	53
26	88	83	60	63518	56	74
27	59412	60806	83	40	78	96
28	35	29	62205	62	64900	66318
29	58	53	28	85	22	40
30	82	76	31	63607	44	60

	36	37	38	39	40	41
M	Parts.	Parts.	Parts.	Parts.	Parts.	Parts.
31	59505	60899	62274	63630	64966	66283
32	29	60922	96	52	89	66305
33	52	45	62319	75	65011	27
34	75	68	42	97	33	49
35	99	91	65	63719	55	70
36	59622	61014	87	42	77	92
37	45	37	62410	64	99	66414
38	69	60	33	87	65211	36
39	92	83	56	63809	43	57
40	59715	61106	78	32	65	79
41	39	29	62501	54	87	66510
42	62	52	24	76	65209	23
43	85	75	46	99	31	44
44	59809	98	69	63921	53	66
45	32	61221	92	43	75	88
46	51	44	62615	66	98	66609
47	79	67	37	88	65320	31
48	59902	90	60	64010	42	53
49	25	61313	83	33	4	74
50	48	36	62705	55	86	96
51	72	59	28	77	65408	66718
52	55	82	51	64100	30	39
53	60018	61405	73	22	52	61
54	42	28	69	44	74	83
55	65	51	62818	67	96	66804
56	88	74	41	89	65518	26
57	60111	97	64	64211	40	48
58	35	61520	86	34	61	69
59	58	43	62909	56	83	91
60	81	66	32	78	65605	66913

D	42	43	44	45	46	47
M	Parti.	Parti.	Parti.	Parti.	Parti.	Parti.
1	66934	68221	69486	70731	71954	73155
2	36	42	69507	51	74	75
3	77	63	28	72	94	54
4	99	84	49	92	72014	73214
5	67021	68306	70	70813	34	34
6	42	27	91	33	55	54
7	64	48	69612	34	75	74
8	85	70	33	75	95	93
9	67107	91	53	95	72115	73312
10	28	80412	74	70916	35	33
11	50	33	95	36	55	53
12	72	45	69716	67	75	72
13	93	75	37	77	96	92
14	67215	97	58	98	72216	73412
15	36	68518	79	71018	26	32
16	58	39	96	39	56	51
17	79	60	66820	56	76	71
18	67301	81	41	79	96	91
19	22	68603	62	71100	72316	73501
20	44	34	83	20	36	30
21	65	45	69902	41	56	50
22	87	66	24	62	77	70
23	67408	87	45	83	97	90
24	30	68708	66	71202	72417	73609
25	51	29	87	33	57	29
26	73	52	70007	43	57	40
27	94	72	28	62	77	68
28	67516	93	49	84	97	88
29	37	68814	70	71304	72517	73708
30	59	35	90	35	57	27

D	42	43	44	45	46	47
M	Paris.	Paris.	Paris.	Paris.	Paris.	Paris.
31	67580	68856	70111	71345	72557	73747
32	67601	77	33	65	77	67
33	23	98	53	86	97	86
34	44	68919	73	71406	72617	73806
35	66	40	94	26	37	25
36	87	61	70215	47	57	45
37	67709	83	36	67	77	65
38	30	69004	56	87	97	84
39	51	25	77	71508	72717	73904
40	73	46	98	28	37	23
41	94	67	70318	48	57	43
42	67815	88	39	69	77	63
43	37	69109	60	89	97	82
44	58	30	80	71609	72817	74002
45	80	51	70401	30	37	21
46	67901	72	22	50	57	41
47	22	93	42	70	76	60
48	44	69214	63	91	96	80
49	65	35	84	71711	72916	74100
50	86	56	70504	31	36	19
51	68008	77	25	51	56	39
52	29	98	45	72	76	58
53	50	69319	66	92	96	78
54	73	40	87	71812	73016	74217
55	94	61	70607	32	36	42
56	68114	82	28	53	45	36
57	35	69403	48	73	75	56
58	56	23	66	93	95	75
59	78	44	90	71913	73115	74314
60	99	65	70710	33	53	74

D	48	49	50	51	52	53
M	Paris	Paris	Paris	Paris	Paris	Paris
1	74333	73490	76623	77732	788	879881
2	53	75509	41	51	36	98
3	72	28	60	69	54	79916
4	92	47	79	87	72	33
5	74411	66	97	77806	90	51
6	31	83	76716	24	78908	68
7	50	75604	33	42	26	85
8	70	23	33	60	44	80003
9	89	42	72	79	61	20
10	74508	61	91	97	79	38
11	28	80	76809	77215	97	55
12	47	99	28	33	79015	73
13	66	75718	46	52	33	90
14	86	37	65	70	51	80107
15	74605	36	84	88	68	25
16	25	75	76903	78006	86	42
17	44	94	21	24	79104	60
18	63	75813	39	43	22	77
19	83	39	58	19	40	94
20	74702	51	77	79	57	8022
21	21	70	95	97	75	69
22	41	89	77014	78115	93	47
23	60	75908	32	33	79221	64
24	79	27	51	52	81	81
25	99	46	69	70	46	99
26	74818	64	88	88	64	80326
27	37	83	77106	78206	82	33
28	57	76002	25	24	99	51
29	76	21	43	42	79317	68
30	95	12	62	60	35	85

D	48	49	50	51	52	53
M	Parti.	Parti.	Parti.	Parti.	Parti.	Parti.
31	74914	76059	77180	78278	79353	80402
32	34	78	99	97		20
33	53	97	77217	78313	88	37
34	72	75116	36	33	79406	54
35	91	43	54	51	23	72
36	75011	53	73	69	41	89
37	30	72	91	87	59	80506
38	49	91	77310	78405	76	23
39	68	76210	28	23	94	41
40	88	29	47	41	79512	58
41	75107	48	65	59	29	75
42	26	66	84	77	47	92
43	45	83	77402	95	64	80610
44	64	76304	20	78513	82	27
45	83	23	29	31	79600	44
46	75203	42	57	49	17	61
47	22	60	76	67	35	78
48	41	79	94	85	52	96
49	60	98	77512	78603	70	80713
50	79	76417	31	21	88	30
51	99	35	49	39	79705	47
52	75318	44	67	57	23	64
53	37	73	86	75	40	81
54	56	92	77604	93	85	98
55	75	76510	22	78711	75	80816
56	94	29	41	29	93	33
57	75413	48	59	47	79811	59
58	32	67	77	65	28	67
59	51	85	96	83	46	84
60	70	76604	77714	78801	63	80901

D	54	55	56	57	58	59
M	Parts.	Parts.	Parts.	Parts.	Parts.	Parts.
1	80918	81931	81920	83882	84820	85731
2	35	48	36	98	35	45
3	52	65	52	83914	51	61
4	70	81	68	30	66	76
5	87	98	85	46	81	91
6	81004	81015	83001	61	97	85806
7	21	31	17	77	84912	21
8	38	48	33	93	27	36
9	55	65	49	84009	43	51
10	72	81	66	25	58	66
11	89	98	82	40	73	81
12	81106	82114	98	56	89	96
13	23	31	83115	72	85004	85910
14	40	48	30	88	91	25
15	57	64	46	88403	35	40
16	74	81	63	19	50	55
17	91	97	79	35	65	70
18	81208	81214	95	51	81	85
19	15	30	93211	66	96	86000
20	42	47	27	82	85111	14
21	59	64	43	98	26	29
22	76	80	59	84213	42	44
23	93	97	76	29	57	59
24	81310	82313	92	54	72	74
25	27	30	83308	60	87	89
26	43	46	24	76	85203	86103
27	60	63	40	92	81	18
28	77	79	65	84370	33	33
29	94	96	72	23	48	48
30	81411	82412	88	39	64	62

D	54	55	56	57	58	59
M	Parti.	Parti.	Parti.	Parti.	Parti.	Parti.
31	81428	82429	83404	84354	85279	86177
32	45	45	30	70	94	92
33	62	62	36	86	85109	86207
34	79	78	52	84401	24	21
45	95	94	68	63	39	36
36	81512	82511	84	32	55	51
37	26	27	83500	48	76	66
38	46	44	16	63	85	80
39	63	60	32	79	85400	95
40	80	77	48	95	15	86310
41	96	93	64	84510	30	24
42	81613	82609	80	26	43	32
43	30	26	96	41	60	54
44	47	42	83612	57	76	68
45	64	58	38	72	91	83
46	84	75	44	88	85506	98
47	97	91	60	84603	31	86412
48	81714	82708	76	19	36	27
49	31	24	92	34	51	42
50	48	40	83708	50	66	56
51	64	57	24	65	81	71
52	81	73	40	81	69	58
53	98	89	55	88	85611	86500
54	81814	82806	71	84712	26	15
55	31	22	87	27	41	29
56	48	38	83801	34	56	44
57	56	54	19	18	71	58
58	81	71	35	73	86	73
59	98	87	51	89	85701	87
60	81915	82903	67	84804	16	86602

D	60	61	62	63	64	65
M	Parts	Parts	Parts	Parts	Parts	Parts
1	86617	87476	88308	89143	89891	90643
2	31	90	22	27	89904	31
3	90	87504	33	40	17	67
4	60	18	88342	53	30	79
5	75	32	62	89166	43	92
6	89	87546	76	79	89955	90704
7	86404	60	90	92	68	16
8	18	74	88403	89206	81	28
9	33	88	17	19	93	41
10	47	87901	30	32	60066	90753
11	62	16	44	45	19	65
12	76	30	88458	89258	31	77
13	92	44	71	75	44	89
14	86805	87658	85	84	90057	90802
15	19	72	98	97	69	14
16	30	88	88512	89310	85	26
17	48	87700	25	24	95	38
18	63	14	39	37	90107	90840
19	77	28	52	50	20	62
20	91	42	88566	89363	32	75
21	86906	87756	79	76	45	87
22	10	70	92	89	98158	99
23	35	84	88606	89402	70	90911
24	140	98	20	15	83	23
25	62	87812	33	28	95	35
26	78	26	47083	41	90208	47
27	94	49	88600	89452	26	90952
28	87006	53	74	67	33	71
29	210	62	87	80	46	84
30	35	87881	88705	89491	90558	96

N	60	61	62	63	64	65
M	Part.	Part.	Part.	Part.	Part.	Part.
31	87049	87895	88714	89508	90271	91008
32	64	87909	27	19	83	26
33	78	23	41	32	96	32
34	92	37	54	45	90308	19 44
45	87107	51	88708	89558	21	91058
36	21	87964	81	71	35	68
37	35	78	94	84	46	80
38	94	92	88808	97	90358	18 92
39	64	88006	21	80609	70	91104
40	87	20	35	32	83	16
41	92	33	48	35	95	18
42	87106	47	88861	44	90408	40
43	21	88061	75	89661	20	91162
44	35	75	88	74	33	64
45	49	89	88954	87	45	76
46	63	88102	19	89700	90457	88
47	78	16	28	12	70	91200
48	92	30	41	25	82	12
49	87306	44	88901	38	95	23
50	20	88157	68	89751	90507	35
51	34	71	81	64	19	91247
52	48	85	94	77	32	59
53	63	98	89008	89	44	71
54	77	88212	21	89802	90556	83
55	91	26	34	15	69	95
56	87401	40	47	28	81	91307
57	19	53	89060	41	93	19
58	33	88267	74	89853	90606	30
59	47	81	87	66	18	42
60	61	94	89100	79	30	91354

D	66	67	68	69	70	71
M	Parts.	Parts.	Parts.	Parts.	Parts.	Parts.
1	91366	92061	92729	93368	93979	94561
2	78	73	40	78	89	70
3	90	84	51	89	99	80
4	91401	95	61	99	94009	89
5	13	92107	92721	93410	18	99
6	25	18	83	20	28	94608
7	37	29	94	30	38	17
8	81448	41	92805	41	48	27
9	60	92152	16	93451	94558	36
10	72	63	26	61	68	47
11	84	75	37	72	78	94655
12	95	86	92848	82	88	64
13	91507	97	59	93	97	74
14	19	92208	70	93503	94107	83
15	31	20	80	13	17	93
16	42	31	91	23	27	94702
17	91554	42	92902	34	37	11
18	66	92253	13	93544	74	21
19	77	65	24	54	94156	30
20	89	76	34	64	66	39
21	91601	87	92945	75	76	94748
22	12	98	56	83	86	58
23	24	92309	66	95	95	67
24	37	21	77	93605	94205	76
25	91647	32	88	16	15	86
26	59	43	99	26	25	95
27	71	92354	93009	36	34	94804
28	82	65	20	46	44	13
29	94	76	31	57	94254	23
30	91706	92387	93041	67	64	32

D	66	67	68	69	70	71
M	Parti.	Parti.	Parti.	Parti.	Parti.	Parti.
31	91717	91399	93052	93677	94273	94841
32	29	92410	62	87	83	50
33	40	21	73	97	93	60
34	52	32	84	93707	94302	69
35	91763	43	94	18	12	94878
36	73	92454	93105	28	22	87
37	87	65	16	38	31	96
38	98	70	26	93748	41	94905
39	91810	87	37	68	94351	15
40	21	28	93147	68	60	24
41	33	92509	38	78	70	33
42	44	20	69	88	80	42
43	91856	32	79	98	89	51
44	67	43	90	93809	99	94960
45	79	92554	93200	19	94408	69
46	90	63	11	29	18	79
47	91902	76	21	39	28	88
48	13	87	32	93849	37	97
49	24	98	93242	59	47	95006
50	36	92609	53	69	94456	15
51	91947	20	63	79	66	42
52	59	30	74	89	75	33
53	70	41	84	99	86	42
54	82	92652	95	93909	94	51
55	39	63	93305	19	94504	95060
56	92004	74	19	29	13	69
57	16	85	26	39	23	78
58	27	96	37	93949	32	87
59	39	92707	47	59	41	96
60	92050	18	93358	69	94551	95105

	72	73	74	75	76	77
D	Paris	Paris	Paris	Paris	Paris	Paris
1	95114	95638	96134	96609	97036	97443
2	23	42	42	42	43	59
3	32	50	50	50	50	96
4	41	64	58	22	75	63
5	50	95672	66	30	64	69
6	95152	81	74	37	97071	76
7	68	82	82	45	78	82
8	77	88	90	52	83	89
9	86	95700	98	60	93	95
10	95	85	96205	67	99	97502
11	95204	88	93	74	97106	08
12	93	81	91	82	13	14
13	92	40	89	89	20	21
14	930	95748	87	97	27	27
15	49	87	96145	96704	34	97534
16	95248	65	113	11	97141	40
17	77	73	61	39	48	47
18	90	95782	69	26	54	53
19	74	80	96277	34	61	59
20	83	98	34	96741	97168	97566
21	92	95807	92	48	75	72
22	95301	935	96300	36	82	78
23	10	23	08	63	89	85
24	19	32	16	70	96	91
25	127	40	24	96778	97102	98
26	136	95848	96331	85	9	97604
27	45	37	39	92	16	10
28	54	65	48	96800	23	16
29	62	73	55	07	30	23
30	95371	95881	96363	14	97236	97629

D	72	73	74	75	76	77
M	Paris.	Paris.	Paris.	Paris.	Paris.	Paris.
31	95380	95890	96370	96822	97243	97635
32	89	98	78	29	50	42
33	07	95908	86	36	57	48
34	95406	14	94	43	64	54
35	15	23	96401	51	70	60
36	95414	31	09	96858	97277	67
37	32	89	17	65	84	97673
38	41	95947	24	72	91	79
39	50	58	32	79	99	85
40	95458	64	96440	87	97304	92
41	67	72	48	94	11	98
42	76	95980	55	96901	17	97704
43	84	88	63	08	24	10
44	92	98	96471	15	31	16
45	95501	96004	78	23	97327	23
46	10	13	86	30	44	29
47	19	21	94	96975	51	97735
48	27	29	96501	44	57	41
49	36	37	06	51	64	47
50	95560	96043	16	58	97335	53
51	43	53	24	65	77	60
52	02	61	96532	96973	84	97668
53	70	63	35	86	90	72
54	79	96079	47	87	97	78
55	95587	85	58	94	97404	84
56	96	94	62	97001	10	90
57	95604	96102	96590	08	17	96
58	12	16	77	15	23	07892
59	21	18	88	22	30	08
60	30	26	96591	97015	97437	12

D	78	79	80	81	82	83
M	Parti.	Parti.	Parti.	Parti.	Parti.	Parti.
1	97820	98168	98485	98771	99030	99328
2	26	73	90	177	34	61
3	32	79	95	8	38	65
4	38	84	98500	86	42	68
5	44	90	05	91	46	72
6	98850	95	10	98795	99050	99275
7	56	98201	15	98800	54	79
8	62	06	20	04	58	82
9	68	12	98525	09	62	85
10	74	17	29	12	66	89
11	97880	22	31	18	99070	99293
12	86	98228	40	98822	74	96
13	91	34	45	27	78	99300
14	98	39	98550	28	82	02
15	97904	45	55	36	86	06
16	10	50	60	40	99090	10
17	16	98255	65	98844	94	13
18	22	61	70	49	98	99217
19	28	66	98575	53	99103	20
20	97934	72	80	58	06	22
21	39	77	85	62	09	27
22	45	98287	89	98866	11	30
23	51	88	94	71	17	99333
24	17	93	99	75	20	37
25	97963	98	98604	79	25	40
26	69	98304	09	84	26	43
27	75	90	14	68888	33	47
28	80	14	18	92	36	99350
29	86	20	23	97	40	53
30	97992	98325	28628	98901	99144	57

D	78	79	80	81	82	83
M.	Parti.	Parti.	Parti.	Parti.	Parti.	Parti.
31	97998	98330	98633	98903	99148	99360
32	98004	36	38	10	51	64
33	09	41	42	14	55	67
34	15	46	47	18	59	70
35	21	51	72	22	63	73
36	27	98357	98657	98927	99167	99376
37	98032	62	61	31	70	80
38	38	67	66	35	74	83
39	44	72	71	39	78	86
40	50	78	76	44	82	88
41	55	98383	98680	98948	99183	99392
42	98061	88	85	52	89	96
43	67	94	90	56	93	99
44	72	98	94	60	98	99402
45	78	98402	99	65	99100	03
46	84	09	98704	98969	04	08
47	89	14	08	73	07	11
48	95	19	13	77	11	15
49	98103	24	18	80	13	99418
50	06	98419	22	83	99218	20
51	12	000 34	98717	98990	000 22	24
52	18	40	32	94	25	27
53	23	45	36	98	29	30
54	98119	50	41	99002	33	99433
55	34	98453	45	06	99236	36
56	40	000 60	98750	10	000 40	39
57	46	65	55	14	44	000 43
58	51	70	59	08	18	47
59	57	75	64	22	52	99449
60	98162	98480	98768	99025	99256	52

D	884	885	886	887	888	889
M.	Paris.	Paris.	Paris.	Paris.	Paris.	Paris.
01	88455	88622	88758	88864	88938	89085
2	58	24	68	3	40	85
3	61	27	62	67	41	86
4	64	22	64	68	42	85
5	67	32	68	70	43	87
6	88470	88634	88768	88874	88948	89095
7	73	37	70	73	45	88
8	76	38	72	74	45	88
9	79	41	74	75	46	88
10	82	44	76	77	47	89
11	88485	88648	88778	88878	88948	89095
12	88	49	80	79	49	90
13	91	51	82	80	50	90
14	93	54	83	82	51	90
15	95	56	84	83	52	91
16	98	59	87	84	53	91
17	99	61	89	86	54	92
18	05	63	92	88	56	92
19	08	66	95	90	58	92
20	12	68	96	91	58	92
21	14	69	97	92	59	93
22	17	72	99	94	58	93
23	19	73	99	95	59	94
24	22	75	00	97	60	94
25	25	78	01	98	61	94
26	28	80	02	99	62	95
27	31	84	03	99	63	95
28	34	88	04	99	64	95
29	37	91	05	99	65	96
30	39	92	06	99	66	96

D	84	85	86	87	88	89
M	Parts	Parts	Parts	Parts	Parts	Parts
31	99542	99694	99815	99906	99965	99996
32	43	96	17	07	66	96
33	47	98	18	08	67	96
34	50	99700	20	09	67	97
35	53	03	22	11	68	97
36	99556	05	99823	99912	99969	97
37	58	07	25	13	70	99997
38	61	09	27	14	70	97
39	64	99711	29	15	71	98
40	67	14	30	17	72	98
41	99569	16	99832	99918	99972	98
42	72	18	34	19	71	98
43	75	20	35	20	74	99998
44	77	99722	37	21	74	98
45	80	25	39	22	75	99
46	99583	27	99840	99924	99976	99
47	85	29	42	25	76	99
48	88	31	44	26	77	99
49	91	99733	45	27	78	99999
50	93	35	47	28	78	99
51	99596	37	99848	99929	79	99
52	98	39	50	30	80	99
53	99601	42	52	31	81	99
54	04	99744	53	32	81	99
55	06	46	55	33	82	99999
56	09	48	99856	99934	99982	99
57	11	50	58	35	83	99
58	99614	52	59	37	83	99
59	16	54	61	38	84	100000
60	19	56	62	99939	99984	100000